SUOMEN GEOLOGINEN TOIMIKUNTA

BULLETIN
DE LA
COMMISSION GÉOLOGIQUE
DE FINLANDE

N:o 136

SUOMEN GEOLOGISEN SEURAN JULKAISUJA
MEDDELANDEN FRÅN GEOLOGISKA SÄLLSKAPET I FINLAND
COMPTES RENDUS DE LA SOCIÉTÉ GÉOLOGIQUE DE FINLANDE

XVIII

AVEC 3 DIAGRAMMES, 11 TABLEAUX, 2 CARTES ET 11 FIGURES DANS LE TEXTE
ET 2 PLANCHES.

HELSINKI
DÉCEMBRE 1945

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IMPRIMÉRIE DE L'ÉTAT

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SUOMEN GEOLOGINEN SEURA.
GEOLOGISKA SÄLLSKAPET I FINLAND.

JÄSENLUETTELO 30. VI. 1945. LIST OF MEMBERSHIP.

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Aulanko, Heikki, Dipl. ins.	Malmikaivos Oy., Ratakatu 29, Helsinki
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*Backlund, H. G., Prof.	Univ. geol. Inst., Uppsala, Sverige
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*Dahlström, Elis, Fil. lic.	Bolidens Gruv A.-B., Västmannagatan 13, Stockholm, Sverige
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Enkovaara, Antti, Yliopp.	Hakaniementori 1 C 21, Helsinki
Erämetsä, Olavi, Tekn. toht.	Lönnrotinkatu 45 A 15, Helsinki
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v. Gaertner, Hans Rudolf, Dr.	Preuss. Geol. Landesanst., Invalidenstr. 44, Berlin N 4, Deutschland
*Gavelin, Sven, Fil. Dr., Docent	S.G.U., Stockholm 50, Sverige
Gevers, T. W., Prof.	Geological Dept. of the University of Witwatersrand, Johannesburg, South Africa
Granö, J. G., Prof.	Kristiinank. 1, Turku
*Grip, Erland, Fil. lic., Chefsgeolog	Bolidens Gruv A.-B., Boliden, Sverige
Grönros, Y., Dipl. ins.	Vänr. Stoolink. 3 A 14, Helsinki
Haapala, Paavo, Fil. toht.	Geologinen toimikunta, Bulevardi 29, Helsinki
Halinen, Vihtori, Vuori-ins.	Museok. 30 A 8, Helsinki
Hall, A. Jean, M. A.	Dept. of Min. & Petr., Downing Street, Cambridge, England
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Heiskanen, V. A., Prof.	Messeniuksenk. 10 A, Helsinki
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*Hjelmqvist, Sven, Fil. Dr., Statsgeolog	S.G.U., Stockholm 50, Sverige
Holm, Caj, Tekn. yliopp.	Iso Robertink. 35 C 42, Helsinki
*Homma, Fujio, Prof.	Institute of Petrology and Geology, Imperial University, Kyoto, Japan
Hyyppä, Esa, Fil. toht., dosentti, valtiongeologi	Geologinen toimikunta, Bulevardi 29, Helsinki
Hämäläinen, Viljo, Yliopp.	Pääskylänrinne 4 A 32, Helsinki
Härme, M., Yliopp.	Järvenpää
Häyrynen, Matti, Dipl. ins.	Iso Puistotie 1 A 6, Munkkiniemi
*Janusson, Vladimir, Stud. rer. nat.	Paleontologiska Institutet, Uppsala, Sverige
Joensuu, Oiva I., Yliopp.	Pieni Robertink. 10 as. 21, Helsinki
Jäntti, Lauri O. A., Fil. maist.	Puolimatkank. 23 A 13, Tampere
Järnefelt, Olai, Fil. maist.	Bernhardink. 5 A, Helsinki
Kahma, Aarno, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
Kaitaro, Simo, Yliopp.	Runeberginк. 48 A 13, Helsinki
Kalajoki, Reino, Fil. maist.	Töölöntorink. 9, Helsinki
Keränen, Jaakko, Prof.	Ilmatieteellinen Keskuslaitos, Vuorik. 24, Helsinki
Kivekäs, E. K., Fil. maist.	Honkatie 4 B 45, Helsinki

Kivinen, Erkki, Prof.	Mariank. 13 b B, Helsinki
v. Knorring, Oleg, Fil. mag.	Pohjolag. 1 C 25, Helsingfors
Kokkonen, Pekka, Prof.	Fredrikink. 12, Helsinki
Koponen, J. S. W., Lehtori	Kirkkokatu 25, Kajaani
Koponen, Olavi, Dipl. ins.	Koskenk. 11 D 85, Turku
Kotilainen, Mauno J., Prof.	Korkeavuorenk. 8 C, Helsinki
Kranck, E. H., Prof.	Engelplatsen 5 A, Helsingfors
Kuenen, H., Dr. Ph.	Geol. Inst., Groningen, Nederland
*Kulling, Oscar, Fil. Dr., Docent	Östermalmsg. 44, Stockholm, Sverige
Laakso, Perttu, Fil. toht.	Yliopiston kemian laitos, Hallitusk. 5, Helsinki
*Laitakari, Aarne, Prof., Geologisen toimikunnan johtaja	Bulevardi 29, Helsinki
Laitakari, Lauri, Kapt.	Koivula, Korso
Landergren, Sture, Fil. lic., Laborator	S.G.U., Stockholm 50, Sverige
Lehijärvi, Mauno, Ylioppp.	Pursimiehenk. 9 A 15, Helsinki
Leiviskä, Iivari, Prof.	Museok. 9, Helsinki
Linna, Antti, Dipl. ins.	Postik. 7, Lohja
*Lokka, Lauri, Fil. toht.	Mannerheimintie 35 A, Helsinki
Lukkala, O. J., Prof.	Aurorank. 19 A, Helsinki
Lunnasvaara, Väinö, Fil. maist.	Puistolinna, Forssa
Lupander, Kurt, Fil. mag., Disponent	Mätäsvaara gruva, Viekki
Maijala, Paavo, Dipl. ins.	Mineral. laitos, Tekn. Korkeakoulu, Helsinki
Marmo, Vladi, Fil. kand.	Geologinen toimikunta, Bulevardi 29, Helsinki
*Martna, Jüri, Stud. rer. nat.	Torsvikssvängen 16 III, Lidingö, Sverige
Matisto, Arvo, Ylioppp.	Fredrikink. 58 A 12, Helsinki
Mattila, Jorma, Fil. maist.	Töölönk. 36 B, Helsinki
*Meier, Otto, Fil. Dr.	Svenska Diamantbergborrnings A.-B., Kungsgatan 44, Stockholm, Sverige
Mellis, Otto, Dr., Priv. Doz.	L. U. Mineralogijas inst., Kronvalda bulv. 4, Rigā, Latvija, U. S. S. R.
Metzger, A. A. Th., Fil. Dr., Docent	Pargas
Mikkola, Aimo, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
*Mikkola, Toini, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
Mikkola, Toivo S. K., Ylioppp.	Katajanokank. 7 E 39, Helsinki
*Mineralogisch-petrologisches Institut d. Univ.	Bernoullianum, Basel, Helvetia
Mogensen, Fredrik, Tekn. Dr., Bergsingenjör	Ludvika, Sverige
Mäkinen, Eero, Vuorineuvos	Outokumpu Oy., Outokumpu
Mäntynen, Matti, Ylioppp.	Mäenpää, Kärsämäki
Mölder, Karl, Fil. toht.	Geologinen toimikunta, Bulevardi 29, Helsinki
Neuvonen, Kalle, Ylioppp.	Et. Hesperiank. 28 B 30, Helsinki
Nisonen, Eino, Fil. maist.	Töölönk. 36 B, Helsinki
*Noe-Nygaard, Arne, Prof.	Østervoldgade 7, København K, Danmark
Nordenswan, Einar A. O., Fil. maist.	Runeberginк. 17 A, Helsinki
Nordin, Walter, Dipl. ing.	Järnverket, Imatra

Nystén, Henrik, Dipl. ing.	Karlavägen 9—11 A, Drumsö
Ohlson, Birger, Fil. mag.	Grankulla
Ojanperä, Pentti, Fil. maist.	Geologisen toimikunnan laboratorio, E. Esplan. 10, Helsinki
Okko, Veikko, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
Olson, E. O., Mining Engineer	The International Nickel Co. of Canada, Sudbury, Ont., Canada
Parras, Kauko, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
Pehrman, Gunnar, Prof.	Åbo Akademi, Åbo
Pilava-Podgursky, N., Ylioppp.	Hämeentie 39 B, Helsinki
*Popoff, Boris, Prof.	Popoffstr. 8, Rigā, Latvija, U.S.S.R.
Puranen, Maunu, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
*Pääkkönen, Veikko, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
Raiste, Helvi, Fil. maist.	Rauma-Raahe Oy., Rauma
Raja-Halli, Heikki, Dipl. ins.	Suomen Malmi Oy., Otanmäki, Kajaani
Rankama, Kalervo, Fil. toht., dosentti	Geologinen toimikunta, Bulevardi 29, Helsinki
Renvall, Åge, Fil. mag.	Esbo
Sahama, Th. G., Fil. toht., dosentti, valtiongeologi	Geologinen toimikunta, Bulevardi 29, Helsinki
Saksela, Martti, Fil. toht., apulainen	Temppelik. 21, Helsinki
*Salmi, Martti, Fil. toht.	Geologinen toimikunta, Bulevardi 29, Helsinki
Salminen, Kyllikki, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
Saraste, Ahti, Yliopp.	P.ranta 8 B 31, Helsinki
Sauramo, Matti, Prof.	Tunturik. 4, Helsinki
Savolainen, E., Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
Seitsaari, Juhani, Fil. kand.	Unionink. 45 A 12, Helsinki
Simola, Kaarlo, Yliopp.	Outokumpu Oy, Outokumpu
Simonen, Ahti, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
*Sirén, Arne, Fil. Dr.	Ab. Airam Oy., Båtsmansg. 29, Helsingfors
*Soikero, J. N., Geologi	Orimattila
Soininen, Antti, Fil. maist.	Topeliuksenk. 35 A, Helsinki
Soveri, Urpu, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
*Stigzelius, Herman, Tekn. Dr.	Haveri, Viljakkala
Ståhlberg, Elsa, Fil. mag.	Fänrik Stålsg. 11 B 28, Helsingfors
Sundell, I. G., Direktör	Kanalg. 4, Helsingfors
Suominen, Eero E., Fil. maist.	Tehtaank. 1 A, Helsinki
Tammekann, August, Prof.	Synålsv. 8, Riksby, Sverige
Tanner, V., Prof.	Hälsingborg, Sverige
Toivonen, N. J., Prof.	Hallitusk. 3, Helsinki
Tuominen, Heikki, Fil. kand.	Outokumpu Oy., Fabianink. 31, Helsinki
Vaasjoki, O., Yliopp.	Kammiok. 15 D 29, Helsinki
Vahervuori, Teuvo, Yliopp.	Fredrikink. 14 A, Helsinki

Wahl, Walter, Prof.	Kyrkog. 1 b, Helsingfors
Valtasaari, Lea, Fil. kand.	Vironk. 5 A, Helsinki
Varma, Arno, Yliopp.	Urheiluk. 46, Helsinki
Veltheim, Valto, Yliopp.	Fredrikink. 39 C 21, Helsinki
*Wenk, Eduard, Dr.	Mineralogisch-petrologisches Institut d. Univ., Basel, Helvetia
Wessman, Tor H., Fil. mag.	Dagmarg. 5 B 10, Helsingfors
*Wickman, Frans E., Fil. lic.	Dalag. 36, Stockholm, Sverige
Virkkala, Kalevi, Fil. maist.	Geologinen toimikunta, Bulevardi 29, Helsinki
Vähätalo, Veikko, Fil. maist.	Outokumpu Oy., Outokumpu
Väyrynen, Heikki, Prof.	Temppelik. 13, Helsinki
Zans, Verners, Cand. rer. nat.	L. U. Geologijas institūts, Baznicas ielā 5—18, Rigā, Latvija, U.S.S.R.
Zeidler, Waldemar, Dipl. ing.	Ab. Vuoksenniska Oy., Mätäsvaara gruva, Viekki
*Ödman, Olof H., Fil. Dr., Docent, Statsgeolog	S.G.U., Stockholm 50, Sverige

Vakinaiset jäsenet on merkitty tähdellä (*)
The Life Members are indicated by an asterisk (*)

SUOMEN GEOLOGISEN SEURAN TOIMINTA VUONNA 1938.

Geologisella Seuralla on v. 1938 ollut 8 kokousta. Puheenjohtajana on toiminut toht. Erkki Mikkola, sihteerinä allekirjoittanut.

Uusiksi jäseniksi valittiin vuori-ins. Fredrik Mogensen (Ruotsi), prof. V. A. Heiskanen, maist. Martti Salmi, maist. Jorma Mattila ja yliopp. Kauko Parras. Seurassa oli v. 1938 6 ulkomaalaista kirjeenvaihtajajäsentä sekä 109 muuta jäsentä, joista vakinaisia 16. Seuran jäsenistä on v. 1938 kuollut vuori-ins. M. K. Palmunen.

Seuran julkaisuja on vuoden aikana ilmestynyt kaksi nidettä, N:ot XI ja XII. Edellisessä on 1 166 sivun laajuinen kirjoitus, jälkimmäisessä 7 kirjoitusta, yhteensä 107 sivua. Vakinainen valtionavustus oli mk 22 000: — ja ylimääräinen mk 15 000: —.

ACTIVITIES OF THE GEOLOGICAL SOCIETY OF FINLAND IN 1938.

During 1938 8 meetings of the Society were held. Dr. Erkki Mikkola acted as President; the duties of Secretary were attended to by the undersigned.

The following new Members were elected: Mr. Fredrik Mogensen, Mining Engineer (Sweden), Professor V. A. Heiskanen, Mr. Martti Salmi, M. A., Mr. Jorma Mattila, M. A., and Mr. Kauko Parras, Student of Geology. The List of Members included in 1938 6 Foreign Corresponding Members and 109 other Members, 16 of whom were Life Members. Mr. M. K. Palmunen, Mining Engineer, Member of the Society, passed away in 1938.

Two volumes of the »Comptes Rendus» of the Society were published during the year: No. XI containing one paper of 166 pages, and No. XII with 7 papers totalling 107 pages. The ordinary Government subsidy was mks 22 000: —, and the additional subvention mks 15 000: —.

Vuoden 1938 lopussa Seuran taloudellinen asema oli seuraava:
At the close of 1938, the financial position of the Society was the following:

Saldo vuodelta 1937 — Brought forward from 1937	23 126: 50
Valtionavustukset — Government subsidies	37 000: —
Jäsenmaksuja — Membership fees	1 750: —
Korkoja — Interest	522: 95
Summa — Total mk	62 399: 45

Toimistokulut — Office costs	279: 50
Kirjeenvaihto — Correspondence	567: 40
Edustus — Representation costs	422: 10
Toht. W. W. Wilkmanin muistoksi F. J. Wiikin Stipendirahastoon — In memory of the late Dr. W. W. Wilkman to the F. J. Wiik scholarship fund	975: —

Kielentarkastukset — Translation costs	95: —
Painatuskulut — Publishing costs	38 298: 30
Sihteerin palkkio — Secretary's fee	1 000: —
Saldo vuodelle 1939 — Carried forward to 1939	21 262: 15
Summa — Total mk	62 399: 45

Helsinki 21. XII. 1938.

In fidem:
Th. G. Sahama

KOKOUKSET — MEETINGS
1938.

27. I.

Toht. Paavo Haapala: Matkavaikutelmia Sudburyn nikkelimalmialueelta. — Impressions of Travel in the Sudbury Nickel Ore District.

Esitelmöitsijä kuvasi Sudburyn alueen geologiaa ja sen toimivia kaivoksia sekä malmien esiintymistapaa ja niiden syntyä esitellen näytteiden avulla eri malmityypit. — The lecturer dealt with the geology of the Sudbury area, the mines worked, and the mode of occurrence and origin of the ores. The different ore types were demonstrated by hand specimens.

Maist. E. Savolainen näytti Suistamolta tavatun fossiileja sisältävän kalkkikivilohkareen. — *Mr. E. Savolainen, M. A.* showed a fossiliferous limestone boulder, found in the parish of Suistamo.

Toht. Erkki Mikkola: Itä-Lapin kallioperästä. — On the Geology of East Lapland.

Erkki Mikkola: Suomen Geologinen Yleiskartta. — The General Geological Map of Finland. Lehdet — Sheets B 7 — C 7 — D 7. Muonio—Sodankylä—Tuntsajoki. Kivilajikartan selitys — Explanation to the Map of Rocks. Helsinki 1941.

24. II.

Toht. Erkki Mikkola: Lapin kallioperää, granuliittialueelta Länsi-Lappiin. — On the Geology of Lapland, from the Granulite Belt to West Lapland.

Erkki Mikkola: Suomen Geologinen Yleiskartta. — The General Geological Map of Finland. Lehdet — Sheets B 7 — C 7 — D 7. Muonio—Sodankylä—Tuntsajoki. Kivilajikartan selitys — Explanation to the Map of Rocks. Helsinki 1941.

Maist. Antti Salminen esitti tiedonannon Suomen maalajien raekokoomuksen vaihteluista pystysuorassa suunnassa. Karkeampi aines on yleensä päälläpäin ja hienonee alaspäin mentäessä. Karkeuden lisääntyessä piihapon määrä kasvaa ja emästen pienenee, joten maanpinnassa maalajit ovat piihapporikkaampia. — *Mr. Antti Salminen, M. A.*, made a communication about the vertical variations of the grain size in Finnish soils. The coarser material is usually found in the surface layers while the lower layers contain more fine-grained material. Seeing that the coarser layers contain more silica and less femic constituents than the finer ones, the surface layers of the soil are rich in silica.

Toht. Heikki Väyrynen esitti mikrovalokuvia Petsamon nikkelimalmeista. Näiden malmimuodostumien rakenne todistaa kiisujen olevan epigeneettisiä, tunkeutuneen serpentiineihin ja osittain liuskeisiinkin jälkeen päin. — *Dr. Heikki Väyrynen* showed photomicrograms of the nickel ores of Petsamo. As shown by the texture of these ores, the sulphides are epigenetic, and have at a later stage penetrated into the serpentine rocks and, partly, into the schists.

24. III.

Prof. Matti Sauramo: Pohjamoreenin suuntausrakenteesta. — On the Fabric Structure of Ground Moraine.

Esitelmöitsijä selosti saksalaisen Konrad Richterin tutkimuksia muodoltaan pitkulaisten kivien suuntautumisesta moreenissa sekä sen suhteesta jään liikunta suuntaan. — The lecture dealt with the investigations of Konrad Richter (Germany) on the orientation of elongated pebbles in morainic drift and the relation between the orientation and the transportation direction.

Prof. Leon. H. Borgström: Om mineralernas kristallstruktur. — On the Crystal Structure of Minerals.

Esitelmöitsijä selosti W. L. Braggin teosta »Atomic Structure of Minerals». — The lecturer reviewed the book »Atomic Structure of Minerals» by W. L. Bragg.

Toht. Martti Saksela: Laver-kaivoksesta. — On the Geology of the Laver Mine.

Esitelmöitsijä selosti toimintansa alkavaa Laver-kaivosta Älvsbyn pitäjässä Ruotsissa ja näytti kappaleen Bolidenin apatiittia, joka esiintyy arsenimalmilinssien jatkeella. — The lecture dealt with the newly opened Laver Mine in the parish of Älvsby, Sweden. In addition, a specimen of apatite from Boliden, occurring on the extension of the lenticular arsenic ore bodies, was shown by the lecturer.

7. IV.

Pentti Eskola: Liuskeisuuden synty. — The Origin of Schistosity.

Esitelmöitsijä selosti piakkoin ilmestyvään teokseensa sisältyvää, liuskeisuuden syntyyn vaikuttavia ilmiöitä ja tekijöitä käsittelevää osa. — The lecturer reviewed that part of his new book, which deals with the factors and phenomena having influence upon the origin of schistosity.

Yliopp. Veikko Pääkkönen esitti tiedonannon kalsiumkarbonaatin vaikutuksesta eräisiin alkalimineraaleihin. — *Mr. Veikko Pääkkönen, Student of Geology,* made a communication about the influence of calcium carbonate upon some alkali minerals, *viz.*, nepheline, leucite, and microcline.

5. V.

Toht. Erkki Mikkola: Etu-Lapin vanhemmista kvartsiitti-, liuske- ja vihreäkivimuodostumista. — On the Older Quartzite, Schist, and Greenstone Formations in South Lapland.

Erkki Mikkola: Suomen Geologinen Yleiskartta — The General Geological Map of Finland, Lehdet — Sheets B 7—C 7—D 7. Muonio—Sodankylä—Tuntsajoki. Kivilajikartan selitys — Explanation to the Map of Rocks. Helsinki 1941.

Prof. Aarne Laitakari: Tafonirapautuminen ja »Karhunpesäkivi». — Surface Pan Formation and the Boulder »Karhunpesäkivi» (Bear's Den Rock).

Esitelmöitsijä selosti Boris Popoffin ja Irma Kvelbergin Korsikan tafonimuodostumia käsittelevää tutkimusta ja osoitti, että Inarin tunnetun Karhunpesäkiven onkalomuodostumat mitä suurimmassa määrässä muistuttavat tafoneja, joten on ilmeistä, että molempien syntymisen ovat aiheuttaneet samat syyt. — The lecturer reviewed a paper on the tafoni type of weathering in Corsica, published by Boris Popoff and Irma Kvelberg. (Irma Kvelberg und Boris Popoff, Die Tafoni-Verwitterungserscheinung. Acta Univ. Latviensis, Kim. Fak. Ser., IV. 6. 1937.) Seeing that the cavities of the »Karhunpesäkivi», situated in the parish of Inari, Lapland, show a remarkably close resemblance to the tafonis in Corsica, similar causes must have led to the formation of the cavities of the Karhunpesäkivi and of the Corsican tafonis.

Prof. Aarne Laitakari esitti kokoelman tantaliittinäytteitä Kemiöstä. — *Professor Aarne Laitakari* showed a collection of tantalite specimens from Kemiö.

Toht. Olavi Erämetsä esitti tiedonannon havaitsemastaan suomalaisten flogopiittien suuresta rubidiumpitoisuudesta. — *Dr. Olavi Erämetsä* made a communication about his discovery of the high rubidia content of Finnish phlogopites.

13. X.

Prof. Matti Sauramo näytti prof. Huckelta Berliinistä saamansa kovelliittia sisältävän lohkareen sekä fulguriitin Kuhrische Nehrungilta. — *Professor Matti Sauramo* showed a covellite-bearing glacial boulder, obtained by the courtesy of Professor Hucke (Berlin), and a specimen of fulgurite from Kuhrische Nehrung.

Toht. Erkki Mikkola: Kuopion kallioperäkarttalehti Wilkmanin kuvaamana. — The Map of Rocks, Sheet Kuopio, as Desciibed by W. W. Wilkman.

Esitelmöitsijä selosti valtiongeologi W. W. Wilkman-vainajan mainittuun karttalehteen kirjoittamaa selitystä, jonka esittäjä oli täydentänyt ja j,hon hän oli kirjoittanut englanninkielisen selostuksen. — The lecture dealt with the explanation to this map of rocks, a part of the General Geological Map of Finland, written by the late Dr. W. W. Wilkman, State Geologist, completed and annexed with a summary in English by the lecturer.

W. W. Wilkman: Suomen Geologinen Yleiskartta, Lehti C 3 Kuopio. Kivilajikartan selitys (With an English Summary). Helsinki 1938.

24. XI.

Toht. Erkki Aurola: Outokumpu Oy:n suorittamat malmitutkimukset Pohjois-Karjalassa vv. 1935—1938. — The Ore Prospecting Carried out in 1935—1938 by the Mining Company Outokumpu Oy in North Karelia.

Mainittuna aikana on löydetty useita uusia malmilohkareita pääasiassa Höytiäisen ympäristöstä Polvijärven ja Kontiolahden pitäjistä. Kiintokalliosta on löydetty vähin erin rikkikiisua Polvijärven Huutokoskelta, molybdeenihohdetta Kaavin pitäjän Suovaarasta ja kaksi rikkikiisuesiintymää Tuupovaaran pitäjän Hevoskummusta. — During 1935—1938 some new ore boulders were found, mainly in Polvijärvi and Kontiolahti, in the neighbourhood of Lake Höytiäinen. Small pyrite deposits have been found in Huutokoski, parish of Polvijärvi, and molybdenite in Suovaara, parish of Kaavi, while two somewhat larger pyrite deposits were discovered in Hevoskumpu, parish of Tuupovaara.

Erkki Aurola and Veikko Vähätalo, The Pyrite Deposit of Hevoskumpu in Tuupovaara. Bull. Comm. géol. Finlande N:o 125, p. 87. 1939.

Toht. Erkki Mikkola esitti tiedonannon uudesta kallioperäkartoituksesta Etelä-Suomessa. Työtä on tehty 3 vuotta ja kokonaan tutkituiksi on saatu 8 pitäjää. — *Dr. Erkki Mikkola* made a communication about the geological mapping of rocks in South Finland. In 3 years 8 parishes have been mapped in detail.

15. XII.

Valittiin Seuran toimihenkilöt vuodeksi 1939, jolloin valituiksi tulivat: puheenjohtajaksi toht. Heikki Väyrynen, varapuheenjohtajaksi toht. Erkki Kivinen, sihteeriksi ja rahastonhoitajaksi toht. Th. G. Sahama uudelleen sekä tilintarkastajiksi prof. Leon. H. Borgström ja toht. Sampo Kilpi.

The Ballot for the Officials was taken and the following functionaries were elected for the ensuing year, 1939: President, Dr. Heikki Väyrynen; Vice Presicent, Dr. Erkki Kivinen; Secretary and Treasurer, Dr. Th. G. Sahama, re-elected; Auditors, Professor Leon. H. Borgström and Dr. Sampo Kilpi.

Toht. Erkki Mikkola: Kumpu-Oraniemen muodostuma. — The Kumpu-Oraniemi Formation in South Lapland.

Erkki Mikkola: Suomen Geologinen Yleiskartta — The General Geological Map of Finland, Lehdet — Sheets B 7 — C 7 — D 7. Muonio—Sodankylä—Tuntsajoki. Kivilajikartan selitys — Explanation to the Map of Rocks. Helsinki 1941.

Prof. Pentti Eskola esitti valokuvia Venäjän kansainvälisestä geologikongressista v. 1937 sekä herrat Sauramo, Laitakari, Väyrynen, Kilpi, Simonen ja Rankama valokuvia 3. Pohjoismaisesta geologikokouksesta Ruotsissa v. 1938. — *Professor Pentti Eskola* showed photographs of the International Geological Congress, XVII Session, USSR 1937. In addition, photographs of the 3rd North Geologists' Meeting held in Sweden in 1938 were presented by Messrs. Sauramo, Laitakari, Väyrynen, Kilpi, Simonen, and Rankama.

SUOMEN GEOLOGISEN SEURAN TOIMINTA VUONNA 1939.

Geologisella Seuralla on vuonna 1939 ollut 7 kokousta. Puheenjohtajina ovat toimineet prof. Heikki Väyrynen ja toht. Erkki Kivinen sekä sihteereinä toht. Th. G. Sahama ja maist. Kalervo Rankama.

Seuran uudeksi kirjeenvaihtajajäseneksi valittiin prof. Harry von Eckermann Tukholmasta. Seuran jäseniksi valittiin ins. Matti Häyrynen, maist. Kyllikki Salminen, maist. Antti Soininen, maist. Elsa Ståhlberg, yliopp. M. J. Härme, yliopp. Oleg von Knorring, yliopp. Toivo S.A. Mikkola ja yliopp. Erkki M. Rosendal. Seurassa oli v. 1939 7 ulkomaalaista kirjeenvaihtajajäsentä ja 117 muuta jäsentä, joista vakinaisia 16.

Toimivuoden aikana ilmestyi Seuran julkaisujen numero XIII, jossa on 7 kirjoitusta ja 119 sivua. Vakinainen valtionavustus oli yhteensä mk 22 000: — ja ylimääräinen mk 15 000: —.

ACTIVITIES OF THE GEOLOGICAL SOCIETY OF FINLAND IN 1939.

During 1939 7 meetings of the Society were held. Professor Heikki Väyrynen and Dr. Erkki Kivinen acted as Presidents; the duties of Secretary were attended to by the undersigned and by Mr. Kalervo Rankama, M. A.

Professor Harry von Eckermann, of Stockholm, was elected Foreign Corresponding Member of the Society. The following were elected Members: Mr. Matti Häyrynen, Civil Engineer; Miss Kyllikki Salminen, M. A.; Mr. Antti Soininen, M. A.; Miss Elsa Ståhlberg, M. A.; and Messrs. M. J. Härme, Oleg von Knorring, Toivo S. A. Mikkola, and Erkki M. Rosendal, Students of Geology. The List of Members included in 1939 7 Foreign Corresponding Members and 117 other Members, 16 of whom were Life Members.

Of the »Comptes Rendus» of the Society, the 13th volume with 7 papers totalling 119 pages has been published. The ordinary Government subsidy was mks 22 000: — and the additional subvention mks 15 000: —.

Vuoden 1939 lopussa Seuran taloudellinen asema oli seuraava:
At the close of 1939, the financial position of the Society was the following:

Saldo vuodelta 1938 — Brought forward from 1938	21 262: 15
Valtionavustukset — Government subsidies	24 000: —
Korkoja — Interest	729: 55
Summa — Total mk	45 991: 70
Toimistokulut — Office costs	1 547: 50
Kielentarkastuksia — Translation costs	79: —
Painatuskulut — Publishing costs	18 517: 50
Sihteerin palkkio — Secretary's fee	1 000: —
Saldo vuodelle 1940 — Carried forward to 1940	24 847: 70
Summa — Total mk	45 991: 70

Helsinki 4. X. 1940.

In fidem:
Th. G. Sahama.

KOKOUKSET — MEETINGS

1939.

18. I.

Prof. E. H. Kranck: Labradorkustens betydelse för den geologiska konnektionen mellan Nordamerika och Grönland. — The Significance of the Rock-Ground of the Coast of Labrador for the Connection between the Pre-Cambrian of North America and Greenland.

E. H. Kranck, The Rock-Ground of the Coast of Labrador and the Connection between the Pre-Cambrian of Greenland and North-America. Bull. Comm. géol. Finlande N:o 125, p. 65. 1939.

Prof. Pentti Eskola: Hiilen kiertokulusta. — On the Cycle of Carbon.

Esitelmöitsijä selosti etupäässä V. M. Goldschmidtin kvantitatiivista selvitystä hiilidioksidin pelkistymisestä vihreissä kasveissa fotosynteesin avulla sekä »fossiilisen» ja vapaan hapen määristä ja käsitteli niitä johtopäätöksiä geologiseen kehitykseen nähden, joita olisi pakko tehdä jos otaksutaan, että ilman happimäärä on geologisten aikojen kuluessa vähitellen kertynyt hiilidioksidin pelkistyessä. — The lecturer reviewed the accounts given especially by V. M. Goldschmidt on the reduction of carbon dioxide in living plants by the aid of photosynthesis, and on the amount of fossil and free oxygen. The deductions concerning the course of the geological evolution, compelled by the assumption of the origin of oxygen in the atmosphere through the reduction of carbon dioxide during geological times, were also dealt with in the lecture.

Pentti Eskola, Maapallon hiili, happi ja elämä. Suom. Tiedeakat. Esit. ja Pöytäkirj. 1939. p. 70.

Toht. Erkki Kivinen: Moreenimaiden ominaisuuksista vaara-alueilla. — On the Properties of the Morainic Soils in the »Vaara»-Regions.

Esitelmöitsijä kuvasi kesällä 1938 tutkimaansa Itä-Suomen vaara-alueilla tavattavaa moreenityyppiä, jolle on ominaista löyhärakenteinen pintakerros ja sen alla erittäin kova ja tiivis sekä vaikeasti vettä läpäisevä pohjamoreenikerros. — The lecturer described a moraine type investigated by him in the summer of 1938 in the »Vaara»-regions of East Finland. This moraine consists of a loose surface part overlying a very dense, hard, and impervious layer of ground moraine.

Toht. Thord Brenner esitti tiedonannon »Skred i Ilmajoki». — *Dr. Thord Brenner* made a communication about the landslide in the parish of Ilmajoki.

23. II.

Toht. Heikki Väyrynen: Outokummun alueen tektoniikasta. — On the Tectonics of the Outokumpu Region.

Heikki Väyrynen, On the Geology and Tectonics of the Outokumpu Ore Field and Region. Bull. Comm. géol. Finlande N:o 124, 1939.

Toht. Leo Aario esitti tiedonannon Kolosjoelta löydetyistä pyöriäisen luista. — *Dr. Leo Aario* made a communication about the discovery of porpoise bones in Kolosjoki, Petsamo.

Leo Aario: Der Tümmlerfund von Kolosjoki und die Entwicklungsgeschichte der Wälder Petsamos. Fennia 66. N:o 4. 1940.

23. III.

Dr. Harry von Eckermann (Stockholm): De alkalina bergarternas genesis i belysning av nya forskningsrön från Alnön. — The Genesis of Alkaline Rocks as Illustrated by New Investigations in Alnö.

Harry von Eckermann, De alkalina bergarternas genesis i belysning av nya forskningsrön från Alnön. Geol. Fören. Förh., Bd. 61, p. 142. 1939.

Toht. Harry von Eckermann esitti värielokuvia geologisilta retkeilyiltä. — *Dr. Harry von Eckermann* presented colour films from geological excursions.

20. IV.

Prof. Matti Sauramo: Suomen metsien historia. — The History of Finnish Forests.

Esitelmä käsitteli uusia, siitepölytilastoon perustuvia tutkimuksia, jotka esitelmöitsijä oli suorittanut yhdessä yliopp. O. V. Lumialan kanssa. — The lecture dealt with recent studies, based on pollen statistics, and carried out by the lecturer in cooperation with Mr. O. V. Lumiala, Student of Geology.

Matti Sauramo: Die Geschichte der Wälder Finnlands. Geol. Rdsch., Bd. 32, p. 579. 1941.

Toht. Th. G. Sahama esitti tiedonannon wiikiitin maametallikokoomuksesta. — *Dr. Th. G. Sahama* made a communication about the rare-earth content of wiikite.

Th. G. Sahama and Veikko Vähätalo, The Rare-Earth Content of Wiikite. Bull. Comm. géol. Finlande N:o 125, p. 97. 1939.

29. IV.

Toht., dosentti Paul Thomson Tallinnasta piti esitelmän äskettäin Etelä-Virossa löydetystä interglasiaalisesta suosta ja siihen sisältyvästä siitepölyflorasta. — *Dr. Paul Thomson* (Tallinn) gave a lecture about a recently discovered interglacial bog in South Esthonia, and the pollen flora contained in it.

13. V.

Prof. Pentti Eskola näytti Yliopiston Mineralogis-geologisella laitoksella rakennettuja kidemalleja. — *Professor Pentti Eskola* showed models of various crystal structures built up at the Mineralogical and Geological Institute of the University of Helsinki.

Toht. Heikki Väyrynen: Pohjois-Karjalan liuskemuodostumien stratigrafiasta. — On the Stratigraphy of the Schist Formations of North Karelia.

Heikki Väyrynen, On the Geology and Tectonics of the Outokumpu Ore-Field and Region. Bull. Comm. géol. Finlande N:o 124. 1939.

12. X.

Maist. Kalervo Rankama: Silikaattianalyysin piihapposakan sisältämistä epäpuhtauksista. — On the Impurities Contained in the Residue from Silica in Rock-Analysis.

Kalervo Rankama: On the Composition of the Residue from Silica in Rock-Analysis. Bull. Comm. géol. Finlande N:o 126, p. 3, 1941.

Prof. Pentti Eskola esitti tiedonannon kidekellarista selostaen Honkilahdella rapakivessä tavattuja isoja miaroliittisia onteloita ja näyttäen niissä esiintyviä mineraaleja. — *Professor Pentti Eskola* made a communication about miarolitic cavities found in rapakivi granite in Honkilahti. In addition specimens of minerals found in these cavities were displayed.

SUOMEN GEOLOGISEN SEURAN TOIMINTA VUONNA 1940.

Geologisella Seuralla on vuonna 1940 ollut vain 3 kokousta. Puheenjohtajina ovat toimineet prof. Heikki Väyrynen ja toht. Erkki Kivinen sekä sihteerinä toht. Sampo Kilpi.

Seuran uusiksi kirjeenvaihtajajäseniksi on valittu prof. Richard F. Flint New Havenista ja prof. Richard J. Lougee Waterville'ista. Uudeksi jäseneksi on valittu dipl. ins. Heikki Raja-Halli. Seurassa oli 1940 8 ulkomaalaista kirjeenvaihtajajäsentä ja 109 muuta jäsentä, joista vakinaisia 16. Seuran ulkolaisista jäsenistä on vuonna 1940 kuollut prof. Emile Argand Neuchâtelistä. Isänmaan vapauden ja itsenäisyyden turvaamiseksi käydyssä taistelussa kaatuivat seuraavat Seuran jäsenet: prof. Vainö Sihvonen, toht. Jalo Ant-Vuorinen, toht. Erkki Mikkola, toht. Gunnar Brander sekä ylioppilaat Erkki Kuosmala, Eero Malmivuo ja Reino Uusitalo.

Vuoden aikana ei ole ilmestynyt yhtään numeroa Seuran julkaisuja. Vakinainen valtionavustus oli mk 7 000: — ja lisäavustus mk 17 500: —.

ACTIVITIES OF THE GEOLOGICAL SOCIETY OF FINLAND IN 1940.

During 1940 only 3 meetings of the Society were held. Professor Heikki Väyrynen and Dr. Erkki Kivinen acted as Presidents, and the duties of Secretary were attended to by the undersigned.

Professor Richard F. Flint, of New Haven, Conn., and Professor Richard J. Lougee of Waterville, Me., were elected Foreign Corresponding Members of the Society. Mr. Heikki Raja-Halli, Mining Engineer, was elected Member. The List of Members included in 1940 8 Foreign Corresponding Members and 109 other Members, 16 of whom were Life Members. Professor Emile Argand, of Neuchâtel, Member of the Society, passed away in 1940. The following Members were killed in action during the war: Professor Väinö Sihvonen, Dr. Jalo Ant-Vuorinen, Dr. Erkki Mikkola, Dr. Gunnar Brander, and Messrs. Erkki Kuosmala, Eero Malmivuo and Reino Uusitalo, Students of Geology.

No further volumes of the »Comptes Rendus» of the Society were published during the year. The ordinary Government subsidy was mks 7 000: —, the addiional grant mks 17 500: —.

Vuoden 1940 lopussa Seuran taloudellinen asema oli seuraava:
At the close of 1940 the financial position of the Society was the following:

Saldo vuodelta 1939 — Brought forward from 1939	24 847: 70
Valtionavustukset — Government subsidies	26 500: —
Ylipainoksista — Separate copies	2 310: —
Jäsenmaksuja — Membership fees	4 625: —
Korkoja — Interest	1 117: 45
Summa — Total mk	59 400: 15

Painatuskulut — Publishing costs	1 070: 05
Toimistokulut — Office costs	528: —
Edustus — Representation costs	200: —
Sihteerin palkkio — Secretary's fee	1 000: —
Saldo vuodelle 1941 — Carried forward to 1941	56 602: 10
Summa — Total mk	59 400: 15

Helsinki 2. I. 1941.

In fidem:
Sampo Kilpi.

KOKOUKSET — MEETINGS
1940.

17. X.

Toimitettiin Seuran toimihenkilöiden vaali vuodeksi 1940, jolloin valituiksi tulivat: puheenjohtajaksi prof. Heikki Väyrynen, varapuheenjohtajaksi toht. Erkki Kivinen, sihteeriksi ja rahastonhoitajaksi toht. Sampo Kilpi, tilintarkastajiksi prof. Leon. H. Borgström ja ins. Matti Häyrynen.

The Ballot for the Officials was taken and the following functionaries were declared elected for the year 1940: President, Professor Heikki Väyrynen; Vice President, Dr. Erkki Kivinen; Secretary and Treasurer, Dr. Sampo Kilpi; Auditors, Professor Leon. H. Borgström and Mr. Matti Häyrynen, Civil Engineer.

Maist. Martti Salmi: Patagonian postglasiaalisista purkauskerroksista. — On the Postglacial Volcanic Layers in Patagonia.

Martti Salmi, Die postglazialen Eruptionsschichten Patagoniens und Feuerlands. Ann. Acad. Sci. Fennicae A. III. 2. 1941.

Maist. Kalervo Rankama: Geokemiallisesta prospektauksesta. — On Geochemical Prospecting.

Kalervo Rankama, On the Use of the Trace Elements in Some Problems of Practical Geology. Bull. Comm. géol. Finlande N:o 126, p. 90. 1941.

22. XI.

Dr. A. A. Th. Metzger: Om cementpetrografi. — On the Petrography of Cement.

Adolf A. Th. Metzger, Ueber die normative und modale Zusammensetzung einiger Portland- und Brownmillerit-Cemente. Bull. Comm. géol. Finlande N:o 128, p. 40. 1943.

Prof. Pentti Eskola esitti Yliopiston geologian laitoksella valmistettuja uusia kidemalleja. — *Professor Pentti Eskola* showed further models of crystal structures, built up at the Mineralogical and Geological Institute of the University of Helsinki.

11. XII.

Suoritettiin Seuran toimihenkilöiden vaali vuodeksi 1941. Valituiksi tulivat: puheenjohtajaksi toht. Erkki Kivinen, varapuheenjohtajaksi toht. Aaro Hellaakoski, sihteeriksi ja rahastonhoitajaksi toht. Sampo Kilpi sekä tilintarkastajiksi ins. Matti Häyrynen ja toht. Th. G. Sahama.

The Ballot for the Officials was taken and the following functionaries were elected for the ensuing year, 1941: President, Dr. Erkki Kivinen; Vice President, Dr. Aaro Hellaakoski; Secretary and Treasurer, Dr. Sampo Kilpi re-elected; Auditors Mr. Matti Häyrynen, Civil Engineer, and Dr. Th. G. Sahama.

Toht. Anna Hietanen: Appalakkien itäisen osan geologiasta. — On the Geology of the Eastern Part of the Appalachians.

Anna Hietanen, Appalakkien rakennepiirteitä (Summary: On Appalachian Structures). Terra 53, p. 1. 1941.

Dr. Thord Brenner: Slamstenssedimentet i Muhos. — The Siltstone Sediment in Muhos.

Thord Brenner, Ein ungewöhnliches Kalk-Schlammsteinsediment von Muhos in Mittelfinnland. Geol. Rdsch. Bd. 32, p. 535. 1941.

SUOMEN GEOLOGISEN SEURAN TOIMINTA VUONNA 1941.

Geologisella Seuralla on vuonna 1941 ollut 8 kokousta. Puheenjohtajana on toiminut toht. Erkki Kivinen ja sihteereinä toht. Sampo Kilpi sekä maist. Martti Salmi.

Seuran uudeksi kirjeenvaihtajajäseneksi on valittu prof. Hans Cloos Bonnista ja uusiksi jäseniksi prof. August Tammekann, fil. lis. Olge J. Adamson, dipl. ins. Heikki Aulanko, maisterit Perttu Laakso, Väinö Lunnasvaara, Eino Nisonen ja Urpu Soveri sekä ylioppilaat Antti Enkovaara, Viljo Hämäläinen, Aimo Mikkola, Ahti Saraste, Juhani Seitsaari, O. Vaasjoki ja Teuvo Vahervuori. Seurassa oli v. 1941 9 ulkomaista kirjeenvaihtajajäsentä sekä 126 muuta jäsentä, joista vakinaisia 16. Vuonna 1941 ovat Seuran jäsenistä kuolleet vuori-ins. Joh:s Aschan sekä prof. V. Hackman. Maamme vapauden ja itsenäisyyden turvaaminen on vaatinut seuraavien jäsenten hengen: Seuran sihteeri, toht. Sampo Kilpi sekä ylioppilaat Erkki Austi ja Viljo Kanula.

Vuoden aikana ilmestyi Seuran julkaisujen numero XIV, jossa on 6 kirjoitusta ja XXIV + 140 sivua. Lisäksi ovat useat Seuran jäsenet julkaisseet kirjoituksia Geologische Rundschaun niteeseen 32 sisältyvässä »Suomi»-vihkossa. Vakinainen valtionavustus oli mk 4 500: — ja lisäavustus mk 29 750: —.

ACTIVITIES OF THE GEOLOGICAL SOCIETY OF FINLAND IN 1941.

During 1941, 8 meetings of the Society were held. Dr. Erkki Kivinen acted as President, and the duties of Secretary were attended to by Dr. Sampo Kilpi and the undersigned.

Professor Hans Cloos, of Bonn, was elected Foreign Corresponding Member of the Society. The following were elected Members: Fil. lic. Olge J. Adamson, of Oslo; Professor August Tammekann; Mr. Heikki Aulanko, Mining Engineer; Messrs. Perttu Laakso, M. A., Väinö Lunnasvaara, M. A., Eino Nisonen, M. A., and Urpu Soveri, M. A.; Messrs. Antti Enkovaara, Viljo Hämäläinen, Aimo Mikkola, Ahti Saraste, Juhani Seitsaari, O. Vaasjoki, and Teuvo Vahervuori, Students of Geology. The List of Members included in 1941 9 Foreign Corresponding Members and 126 other Members, 16 of whom were Life Members. Of the Members of the Society, Mr. Joh:s Aschan, Mining Engineer, and Professor V. Hackman passed away dur ng 1941. The following Members were killed in action during the war: Dr. Sampo Kilpi, Secretary of the Society, and Messrs. Erkki Austi and Viljo Kanula, Students of Geology.

Volume XIV of the »Comptes Rendus» of the Society, containing 6 articles, totalling XXIV + 140 pages was published during the year. In addition, many Members of the Society published papers in the »Suomi—Finnlandheft», contained in Vol. 32 of the »Geologische Rundschau». The ordinary Government subsidy was mks 4 500: — and the additional subvention mks 29 750: —.

Vuoden 1941 lopussa Seuran taloudellinen asema oli seuraava:
At the close of 1941, the financial position of the Society was the following:

Saldo vuodelta 1940 — Brought forward from 1940....	56 602: 10
Valtionavustukset — Government subsidies	32 500: —
Ylipainoksista — Separate copies	1 342: —
Jäsenmaksuja — Membership fees	8 800: —
Korkoja — Interest	1 266: 80
Summa — Total mk	100 510: 90

Painatuskulut — Publishing costs	6 538: 90
Toimistokulut — Office costs	2 794: 75
Edustus — Representation costs	2 230: 50
Sihteerin palkkio — Secretary's fee	1 000: —
Saldo vuodelle 1942 — Carried forward to 1942	87 946: 75
Summa — Total mk	100 510: 90

Helsinki 9. II. 1942.

In fidem:
Martti Salmi.

KOKOUKSET — MEETINGS
1941.

23. I.

Maist. Veikko Okko: Rantaviivan siirtyminen Oulujärven ympäristössä ja Oulujoen eteläpuolella. — On the Shift in the Shore Line in the Neighbourhood of Lake Oulujärvi and South of the River Oulujoki.

Esitelmöitsijä teki selkoa havainnoistaan alueen muinaisrannoista ja rantaviivan siirtymisestä. — The lecturer gave an account of his observations on the ancient shores and the shift in the shore line in this area.

Maist. Kalervo Rankama esitti tiedonannon niobin ja tantalin esiintymisestä muutamissa Suomen peruskallion graniiteissa. — *Mr. Kalervo Rankama, M. A.* made a communication about the occurrence of niobium and tantalum in some Finnish Archaean granites.

Kalervo Rankama, The Niobium and Tantalum Content of Three Finnish Archaean granites. Bull. Comm. géol. Finlande N:o 128, p. 34. 1943.

13. II.

Yliopp. Toini Mikkola: Neulakvartsista. — On Acicular Quartz.

U-pöydällä tehtyjen havaintojen mukaan täytyy neulakvartsin lamelleja pitää skelettiluontoisina. — According to observations made with the aid of the Fedoroff universal stage, the lamellae of the acicular quartz must be considered as skeleton crystals.

Prof. Matti Sauramo: Jään ja vesipeitteen peräytyminen Joensuun itäpuolella. — On the Retreat of the Glacial Ice Sheet and of the Sea in the Area East of Joensuu.

Esitelmöitsijä käsitteli kysymystä Röksän ja Selkien malmilohkareitten kulkeutumismahdollisuuksista tullen siihen tulokseen, että nämä lohkareet ovat kulkeutuneet luoteesta eikä lännestä. — The lecturer dealt with the question of the transportation directions of the ore boulders found at Röksä and Selkie. According to the lecturer, these boulders have been transported from the northwest and not from the west.

27. II.

Seuran valitseman valiokunnan laatima lausunto Geologisen toimikunnan uudestijärjestelyä koskevasta asetusehdotuksesta luettiin ja hyväksyttiin lähetettäväksi Kauppa- ja teollisuusministeriölle. Seura päätti ehdottaa seuraavat muutokset laki- ja asetusehdotuksiin: 1. Kokoelmainhoitajan viran perustaminen. 2. Tutkimusassistentin viran perustaminen kvartäärigeologiseen osastoon. 3. Geologisen tutkimuslaitoksen päätehtävän, tieteellisgeologisen tutkimuksen vahvistaminen perustamalla sekä kallioperä- että kvartääriosastoon uusi apulaisgeologin virka.

The Geological Society having been asked by the Ministry of Trade and Industry for a statement of opinion concerning a Bill for the reorganization of the Geological Survey of Finland, the report prepared by a special Committee appointed by the Society was presented to the Meeting. The Society resolved to recommend the following amendments of the propositions for Bill and statutes. 1. A Keeper should be appointed to the Staff of the Geological Survey to look after its collections. 2. A new post, *viz.* that of Scientific Assistant should be created at the Department for the Study of Surface Deposits of the Geological Survey. 3. In order to augment research in scientific geology, the most important task of the Geological Survey, two additional post of Assistant Geologists should be added to its Staff; one of these posts should appertain to the Department for the Mapping of Rocks, and the other to the Department for the Study of Surface Deposits.

6. III.

Yliopp. Kauko Parras: Länsi-Uudenmaan kallioperästä. — On the Geology of West Uusimaa.

Kauko Parras, Das Gebiet der Pyroxen führenden Gesteine im westlichen Uusimaa in Südfinnland. Geol. Rdsch., Bd. 32, p. 484. 1941.

27. III.

Prof. Hans Cloos (Bonn a. Rh.): Über Struktur und Funktion von vulkanischen Tuffschloten.

Hans Cloos, Bau und Tätigkeit von Tuffschloten. Geol. Rdsch., Bd. 32, p. 707. 1941.

24. IV.

Prof. Aarne Laitakari esitti tiedonannon Ylämaalta Viipurin rapakivialueelta löydetystä labradorikivikalliosta. — *Professor Aarne Laitakari* made a communication about an occurrence of Labrador rock found in the parish of Ylämaa, and situated on the Viipuri rapakivi granite area.

Prof. August Tammekann: Mannerjäätikön viimeinen peräytyminen Suomenlahden eteläpuolella. — On the Last Stage in the Retreat of the Glacial Ice Sheet South of the Gulf of Finland.

15. V.

Yliopp. Aarno Kahma: Satakunnan oliviinidiabaasin kontakti-ilmiöistä. — On the Contact Phenomena of the Olivine Diabase of Satakunta.

Esitelmässä selostettiin oliviinidiabaasin kontakteissaan aikaansaamia palingeneesi- ja hybridisaatioilmiöitä. — The lecture dealt with the palingenesis and contamination phenomena caused by the olivine diabase in its contacts.

8. XII.

Maist. Martti Salmi valittiin Seuran väliaikaiseksi sihteeriksi ja rahastonhoitajaksi
Mr. Martti Salmi, M. A., was elected acting Secretary and Treasurer of the Society

SUOMEN GEOLOGISEN SEURAN TOIMINTA VUONNA 1942.

Geologisella Seuralla on vuonna 1942 ollut vain 3 kokousta. Puheenjohtajana on toiminut toht. Aaro Hellaakoski ja sihteerinä toht. Martti Salmi.

Seuran uusiksi jäseniksi on valittu toht. Elis Dahlström Tukholmasta, tohtorit Torsten Du Rietz ja Erland Grip Bolidenista, toht. Hans Rudolf von Gaertner Berliinistä, toht. Rolf Eigenfeld Freiburgista i. Br. sekä dipl. ins. Antti Linna. Seurassa oli v. 1942 9 ulkomaista kirjeenvaihtajajäsentä sekä 116 muuta jäsentä, joista vakinaisia 15.

Vuoden aikana ei ole ilmestynyt yhtään uutta numeroa Seuran julkaisuja. Vakinainen valtionavustus on ollut mk 4 500: — ja lisäavustus mk 32 500: —. Seura on prof. Harry von Eckermannilta Tukholmasta saanut lahjoituksena mk 23 280: — jaettavaksi sodasta kärsimään joutuneille geologeille tai heidän omaisilleen. Seura on antanut rahat talvisodassa kaatuneiden toht. Gunnar Branderin ja toht. Erkki Mikkolan lapsille.

ACTIVITIES OF THE GEOLOGICAL SOCIETY OF FINLAND IN 1942.

During 1942 only 3 meetings of the Society were held. Dr. Aaro Hellaakoski acted as President and Dr. Martti Salmi as Secretary.

The following were elected Members of the Society: Dr. Elis Dahlström of Stockholm; Dr. Torsten Du Rietz and Dr. Erland Grip of Boliden; Dr. Hans Rudolf von Gaertner of Berlin; Dr. Rolf Eigenfeld of Freiburg i Br.; Mr. Antti Linna, Mining Engineer. The List of Members included in 1942 9 Foreign Corresponding Members and 116 other Members, 15 of whom were Life Members.

No further volumes of the »Comptes Rendus» of the Society were published during the year. The ordinary Government subsidy was mks 4 500: — and the additional subvention mks 32 500: —. From Professor Harry von Eckermann, of Stockholm, the Society has received a donation, totalling mks 23 280: — to be given to Finnish Geologists or their relatives suffering by the war. The Society has divided the grant among the children of the late Dr. Gunnar Brander and Dr. Erkki Mikkola.

Vuoden 1942 lopussa Seuran taloudellinen asema oli seuraava:

At the close of 1942, the financial position of the Society was the following:

Saldo vuodelta 1941 — Brought forward from 1941	87 946: 75
Valtionavustukset — Government subsidies	39 750: —
Ylipainoksista — Separate copies	265: —
Jäsenmaksuja — Membership fees	4 825: —
Korkoja — Interest	2 915: 75
Summa — Total mk	135 702: 50
Painatuskuluja — Publishing costs	49 744: 55
Toimistokulut — Office costs	853: 75
Edustus — Representation costs	38: —
Sihteerin palkkio — Secretary's fee	1 000: —
Saldo vuodelle 1943 — Carried forward to 1943	84 066: 20
Summa — Total mk	135 702: 50

Helsinki 30. I. 1943.

In fidem:
Martti Salmi.

KOKOUKSET — MEETINGS
1942.

11. III.

Prof. Pentti Eskola: Itä-Karjalan geologiasta. — On the Geology of East Karelia.
Pentti Eskola, Itä-Karjalan kallioperästä. — Deutsches Referat: Über den Felsgrund Ostkareliens. Terra, 53. p. 171. 1941.

Toimitettiin Seuran toimihenkilöiden vaali vuodeksi 1942. Valituiksi tulivat: puheenjohtajaksi toht. Aaro Hellaakoski, varapuheenjohtajaksi toht. Esa Hyyppä, sihteeriksi ja rahastonhoitajaksi maist. Martti Salmi, tilintarkastajiksi ins. Matti Häyrynen ja toht. Th. G. Sahama.

The Ballot for the Officials was taken and the following functionaries were declared elected for the year 1942: President, Dr. Aaro Hellaakoski; Vice President, Dr. Esa Hyyppä; Secretary and Treasurer, Mr. Martti Salmi, M. A.; Auditors Mr. Matti Häyrynen, Civil Engineer, and Dr. Th. G. Sahama.

28. IV.

Prof. Matti Sauramo: Itä-Karjalan kvartääristä. — On the Quaternary Deposits of East Karelia.

Esitelmöitsijä selosti aikaisempia, pääasiassa suomalaisten suorittamia tutkimuksia ja äskeisiä Neuvosto-Venäjän tiedemiesten saavutuksia. — The lecture dealt with earlier investigations, carried out mainly by Finnish scientists, and recent results obtained by Soviet Russian investigators.

Prof. Pentti Eskola esitti tiedonannon Hugo Strunzin kirjasta »Mineralogische Tabellen» vuodelta 1941. — *Professor Pentti Eskola* made a communication about »Mineralogische Tabellen», compiled by Hugo Strunz in 1941.

Pentti Eskola, Ein natürliches System der Mineralien. Bull. Comm. géol. Finlande N:o 128. p. 179. 1943.

10. XII.

Toimitetiin Seuran toimihenkilöiden vaali vuodeksi 1943. Valituiksi tulivat: puheenjohtajaksi toht. Esa Hyyppä, varapuheenjohtajaksi toht. Th. G. Sahama, sihteeriksi ja rahastonhoitajaksi toht. Martti Salmi, tilintarkastajiksi ins. Matti Häyrynen ja maist. E. Savolainen.

The Ballot for the Officials was taken and the following functionaries were declared elected for the year 1943: President, Dr. Esa Hyyppä; Vice President, Dr. Th. G. Sahama; Secretary and Treasurer, Dr. Martti Salmi; Auditors, Mr. Matti Häyrynen, Civil Engineer, and Mr. E. Savolainen, M. A.

Toht. Anna Hietanen: Kalannin alueen geologiasta. — On the Geology of the Kalanti Area.

Anna Hietanen, Über das Grundgebirge des Kalantigebietes im südwestlichen Finnland. Bull. Comm. géol. Finlande N:o 130. 1943.

Toht. Thord Brenner esitti tiedonannon geologisista havainnoistaan Oulujoen Pyhäkosken ympäristössä. — *Dr. Thord Brenner* made a communication about his geological observations around the Pyhäkoski Rapids in the Oulujoki River.

Thord Brenner, Die Bodenbildungen des Muhos-Sediments bei Kieksi. Bull. Comm. géol. Finlande N:o 132. p. 189. 1944.

Toht. Th. G. Sahama ja *maist. Kalervo Rankama* näyttivät värivalokuvia Itä-Karjalasta. — *Dr. Th. G. Sahama* and *Mr. Kalervo Rankama, M. A.* showed colour slides from East Karelia.

SUOMEN GEOLOGISEN SEURAN TOIMINTA VUONNA 1943.

Geologisella Seuralla on vuonna 1943 ollut 4 kokousta. Puheenjohtajana on toiminut toht. Esa Hyyppä ja sihteerinä toht. Martti Salmi.

Seuran ensimmäiseksi kunniajäseneksi on valittu prof. Pentti Eskola. Uusiksi jäseniksi on vuonna 1943 valittu prof. Mauno J. Kotilainen, vuori-ins. Vihtori Halinen, dipl. ins. Olavi Koponen, maist. Lea Valtasaari, luutn. Lauri Laitakari sekä ylіopp. Vladimir Marmo ja Matti Mäntynen. Seuraan kuului v. 1943 1 kunniajäsen, 9 ulkomaalaista kirjeenvaihtajajäsentä ja 134 muuta jäsentä, joista vakinaisia 18.

Vuoden aikana on Seuran julkaisujen numero XV ilmestynyt. Se sisältää 9 kirjoitusta ja 183 sivua. Vakinainen valtionavustus on ollut mk 4 500: — ja lisäavustus yhteensä mk 30 000: —.

ACTIVITIES OF THE GEOLOGICAL SOCIETY OF FINLAND IN 1943.

During 1943 4 meetings of the Society were held. Dr. Esa Hyyppä acted as President, and the duties of the Secretary were attended to by the undersigned.

Professor Pentti Eskola was elected the first Honorary Member of the Society. The following were elected Members: Professor Mauno J. Kotilainen; Mr. Vihtori Halinen, Mining Engineer; Mr. Olavi Koponen, Civil Engineer; Mrs. Lea Valtasaari, M. A.; Lieutenant Lauri Laitakari; Messrs. Vladimir Marmo and Matti Mäntynen, Students of Geology. The List of Members included in 1943 one Honorary Member, 9 Foreign Corresponding Members, and 134 other Members, 18 of whom were Life Members.

Volume XV of the »Comptes Rendus» of the Society, containing 9 papers and totalling 183 pages, was published during the year. The ordinary Government subsidy was mks 4 500: — and the additional subvention mks 30 000: —.

Vuoden 1943 lopussa Seuran taloudellinen asema oli seuraava:
At the close of 1943 the financial position of the Society was the following:

Saldo vuodelta 1942 — Brought forward from 1942	84 066: 20
Valtionavustukset — Government subsidies	44 500: —
Ylipainoksista — Separate copies	345: —
Jäsenmaksuja — Membership fees	3 875: —
Korkoja — Interest	3 167: 80
Summa — Total mk	135 954: —
Painatuskulut — Publishing costs	37 820: —
Toimistokulut — Office costs	1 676: 75
Lahjoitus Kansanavulle — Contribution to the National Help Fund	2 000: —
Sihteerin palkkio — Secretary's fee	1 000: —
Saldo vuodelle 1944 — Carried forward to 1944	93 457: 25
Summa — Total mk	135 954: —

Helsinki 17. I. 1944.

In fidem:
Martti Salmi.

KOKOUKSET — MEETINGS
1943.

25. II.

Toht. Karl Mölder: Resenttisten piilevien merkitys kvartäärigeologisessa tutkimuksessa. — On the Importance of the Recent Diatoms for the Study of Quaternary Geology.

Karl Mölder, Studien über die Ökologie und Geologie der Bodendiatomeen in der Pojo-Bucht. Bull. Comm. géol. Finlande N:o 127. 1943.

6. V.

Prof. W. Wahl: Om möjligheterna att bestämma orogenesernas relativa ålder. — On the Possibilities to Determine the Relative Ages of the Orogenic Cycles.

Walter Wahl, Altersvergleich der Orogenesen und Versuch einer Korrelation des Grundgebirges in verschiedenen Teilen der Erde. Geol. Rdsch. Bd. 34. p. 209. 1943.

Prof. Aarne Laitakari: Unkarin hyödyllisistä kaivannaisista. — On the Mineral Resources of Hungary.

Aarne Laitakari, Unkarin geologian pääpiirteet ja Unkarin hyödylliset kaivannaiset. Unkarin kirja p. 208. Porvoo-Helsinki 1942.

11. XI.

Prof. Heikki Väyrynen: Utajärven-Kiimingin liuskemuodostumasta. — On the Schist Formation of the Utajärvi-Kiiminki Area.

Esitelmän sisältö julkaistaan sarjassa Bull. Comm. géol. Finlande. — The contents of the lecture will be published in the series Bull. Comm. géol. Finlande.

Prof. Aarne Laitakari esitti tiedonannot vuori-ins. Vihtori Halisen Viron palavakivikaivoksista löytämästä trilobiitista, *Pseud..s phus t cticaudatus v..r. l..urso .i*'sta sekä Virossa Jöhvin lähistöllä suoritetuista syväkairauksista. Täällä on magneettisella häiriöalueella kairattu 2 reikää ja peruskalliossa lävistetty kummassakin magnetiittipitoinen karsimuodostuma. — Professor Aarne Laitakari made a communication about a trilobite, *Ps ud..s..phus t cticaud..tus var. laurso i*, found in the pyroschist mines in Esthonia by Mr. Vihtori Halinen, Mining Engineer, and another about the diamond drillings carried out in the neighbourhood of Jöhvi, Esthonia. Two holes have been sunk here in an area in which magnetic anomalies occur, and in both cases skarn-rocks with magnetite have been penetrated in the Archaean formations.

16. XII.

Suoritettiin Seuran toimihenkilöiden vaali vuodeksi 1944. Valituiksi tulivat: puheenjohtajaksi toht. Th. G. Sahama, varapuheenjohtajaksi toht. Martti Salmi, sihteeriksi ja rahastonhoitajaksi maist. Veikko Pääkkönen, tilintarkastajiksi ins. Matti Häyrynen ja maist. E. Savolainen.

The Ballot for the Officials was taken and the following functionaries were declared elected for the year 1944: President, Dr. Th. G. Sahama; Vice President, Dr. Martti Salmi; Secretary and Treasurer, Mr. Veikko Pääkkönen, M. A.; Auditors, Messrs. Matti Häyrynen, Civil Engineer, and E. Savolainen, M. A.

Maist. O. V. Lumiala: Nykyisistä eloperäisistä sedimenteistä ja niiden synnystä. — On the Recent Organogenic Sediments and Their Origin.

Organogenisten sedimenttien laatu on sedimentaatioaltaassa tapahtuvien biologisten prosessien ja ainesten kiertokulun indikaattori, joten sedimenttipetrografiset ja stratigrafiset tutkimukset tuovat lisävalaistusta paitsi sedimenttien syntyä koskeviin myös kvartääribiologisiin ja kvartäärigeologisiin kysymyksiin. — The nature of the organogenic sediments indicates the course of the biological processes and that of the cycle of the materials taking place in the sedimentation basin. Accordingly, studies in sedimentary petrography and stratigraphy will illustrate not only questions connected with the origin of the sediments, but also different problems of Quaternary biology and Quaternary geology.

Prof. Matti Sauramo esitti tiedonannot Karjalan Kannakselta tapaamistaan tuulenhiomista kivistä, erikoislaatuisesta pohjamoreenista ja interglasiaalisesta savesta. — *Professor Matti Sauramo* made communications about dreikanter, about a ground moraine of exceptional quality, and about interglacial clay, all found by him on the Karelian Isthmus.

SUOMEN GEOLOGISEN SEURAN TOIMINTA VUONNA 1944.

Geologisella Seuralla on vuonna 1944 ollut vain 2 kokousta. Puheenjohtajana on toiminut toht. Th. G. Sahama ja sihteerinä maist. Veikko Pääkkönen.

Seuran uusiksi jäseniksi on valittu dipl ins. Herman Stigzelius, maisterit Birger Ohlson ja Maunu Puranen sekä ylioppilaat Vladimir Janusson, Simo Kaitaro, Jüri Martna, Kalle Neuvonen ja Valto Veltheim. Seuraan kuului v. 1944 yksi kunniajäsen, 9 ulkomaista kirjeenvaihtajajäsentä sekä 139 muuta jäsentä, joista vakinaisia 22.

Seuran julkaisuista on vuonna 1944 ilmestynyt 2 uutta numeroa: XVI, jossa on 8 kirjoitusta ja 196 sivua, ja XVII, jossa on yksi kirjoitus ja 91 sivua. Vakinainen valtionavustus oli mk 4 500: — ja lisäavustus mk 29 000: —. Seura on jälleen saanut prof. Harry von Eckermannilta Tukholmasta lahjoituksena mk 11 640: — jaettavaksi sodassa kaatuneitten geologien lapsille. Seura on antanut rahat talvisodassa kaatuneitten toht. Gunnar Branderin ja toht. Erkki Mikkolan lapsille.

ACTIVITIES OF THE GEOLOGICAL SOCIETY OF FINLAND IN 1944.

During 1944 only 2 meetings of the Society were held. Dr. Th. G. Sahama acted as President and Mr. Veikko Pääkkönen, M. A., as Secretary.

The following were elected Members of the Society: Mr. Herman Stigzelius, Mining Engineer; Messrs. Birger Ohlson and Maunu Puranen, M. A.; Messrs. Vladimir Janusson, Simo Kaitaro, Jüri Martna, Kalle Neuvonen, and Valto Veltheim, Students of Geology. The List of Members included in 1944 one Honorary Member, 9 Foreign Corresponding Members, and 139 other Members, 22 of whom were Life Members.

Two further volumes of the »Comptes Rendus» of the Society have been published during the year, *viz.*, Vol. XVI containing 8 papers and totalling 196 pages, and Vol. XVII with one paper of 91 pages. The ordinary Government subsidy was mks 4 500: — and the additional subvention mks 29 000: —. From Professor Harry von Eckermann, of Stockholm, the Society received a further donation, totalling mks 11 640: —, to be given to the children of Finnish geologists killed in action. The grant has been divided by the Society among the children of the late Dr. Gunnar Brander and Dr. Erkki Mikkola, who fell in the Winter War.

Vuoden 1944 lopussa Seuran taloudellinen tila oli seuraava:
At the close of 1944 the financial position of the Society was the following:

Säästö vuodelta 1943 — Brought forward from 1943 ...	93 457: 25
Valtionavustukset — Government subsidies	28 500: —
Jäsenmaksuja — Membership fees	6 450: —
Korkoja ja osinkoja — Interest & dividends	4 125: 80
Muita tuloja — Income not listed above	105: —
Summa — Total mk	132 638: 05

Painatuskuluja — Publishing costs	19 449: 30
Toimistokulut — Office costs	694: 10
Sihteerin palkkio — Secretary's fee	3 000: —
Sekalaisia kuluja — Expenditure not listed above	500: —
Säästö vuodelle 1945 — Carried forward to 1945	108 994: 65
Summa — Total mk	132 638: 05

Helsinki 8. I. 1945.

In fidem:
Veikko Pääkkönen.

KOKOUKSET — MEETINGS

1944.

26. V.

Dipl. ing. Herman Stigzelius: Geologisk beskrivning av Haveri gruvan och dess omgivningar. — A Geological Description of the Haveri Mine and Its Surroundings.

Herman Stigzelius, Über die Erzgeologie des Viljakkalagebietes im südwestlichen Finnland. Bull. Comm. géol. Finlande N:o 134. 1944.

Maist. Veikko Pääkkönen esitti tiedonannon Reposaarella tapaamastaan rapakiveä muistuttavasta graniitista. — *Mr. Veikko Pääkkönen, M. A.*, made a communication about an occurrence of a rapakivi-resembling granite on Reposaari.

7. XII.

Suoritettiin Seuran toimihenkilöiden vaali vuodeksi 1945. Valituiksi tulivat: puheenjohtajaksi toht. Martti Salmi, varapuheenjohtajaksi toht. Paavo Haapala, sihteeriksi ja rahastonhoitajaksi toht. Kalervo Rankama, tilintarkastajiksi ins. Matti Häyrynen ja maist. Eetu Savolainen.

The Ballot for the Officials was taken and the following functionaries were declared elected for the year 1945: President, Dr. Martti Salmi; Vice President, Dr. Paavo Haapala; Secretary and Treasurer, Dr. Kalervo Rankama; Auditors, Messrs. Matti Häyrynen, Civil Engineer, and Eetu Savolainen, M. A.

Prof. Pentti Eskola: Kuhn-Rittmannin teoria maapallon sisuksesta. — The Kuhn-Rittmann Theory of the Interior of the Earth.

Esitelmöitsijä selosti pääkohtia sekä nykyisin hyväksytystä nikkelirautasydänettä edellämainitusta uudesta teoriasta. Hän selosti myös Kuhn-Rittmannin teoriaa koskevaa, prof. Euckenin julkaisemaa arvostelua. — The lecturer dealt with the main features both of the nickel-iron theory, accepted nowadays, and of the new theory. The critical review of the Kuhn-Rittmann theory published by Professor Eucken, Germany, was also set forth by the lecturer.

Prof. Heikki Väyrynen: Lapin kallioperän tektoniikasta. — On the Structural Geology of Lapland.

Esitelmä julkaistaan sarjassa Bull. Comm. géol. Finlande. — The contents of the lecture will be published in the series Bull. Comm. géol. Finlande.

PRO PATRIA

1941—1944

ERKKI AUSTI

VILJO KANULA

SAMPO KILPI

ERKKI ROSENDAL

Erkki Austi

On September 23rd 1941 Ensign Karl Erkki Austi fell in action at Petäjäselkä, Aunus.

Erkki Austi was born on April 17th 1916 at Parainen. From the year 1937 he studied geology at Helsinki University. In the summer of 1934 he acted as assistant to Mr. M. K. Palmunen, Mining Engineer, at Otravaara Mine and participated during the summers of 1936—38 in prospecting work for useful minerals, arranged by the Company Suomen Mineraali Oy. (The Finnish Minerals Ltd.) in different parts of the country.

Viljo Kanula

On August 7th 1941 Lieutenant Aatto Viljo Kullervo Kanula, Student of Geology, was killed in action on the Finnish East Front.

Viljo Kanula was born on September 20th 1911. He commenced his geological studies at Helsinki University in 1933. In accordance with his interests and inclinations he directed his studies especially to economic geology, with the aim of preparing himself for ore investigation in Finland. During several pre-war summers he accordingly participated in practical ore prospecting in this country. From 1939 he further acted as Assistant Researcher at the Geochemical Laboratory of the Mineralogical and Geological Institute of the University of Helsinki.

In Viljo Kanula practical geology in Finland lost a persevering, conscientious, and promising research-worker, who in his life and activity would have been able to enrich considerably the development of his profession.

Sampo Kilpi

Dr. Sampo Kalervo Kilpi was born in Joensuu on February 3rd, 1909. He matriculated from Joensuun Yhteiskoulu (The Joensuu Co-educational School) in 1928, passed his M. A. examination in natural sciences at the Helsinki University in 1933 and his Phil. Licentiate in 1937 with geology as his main subject. He entered the service of the Geological Survey of Finland in 1936 and joined the Army as a volunteer at the outbreak of the Winter War in 1939. On the resumption of hostilities in 1941 he took part in the War as an infantry officer and met a hero's death on August 24th, 1941, at Kiestinki in East Karelia.

Dr. Sampo Kilpi belonged to that student generation of the 1930's from which geography and geology, as well as biological subjects, benefited in the form of a great rejuvenation. In this respect the 1930's were a period of a great advance in natural science in Finland and produced a profusion of young, promising researchers.

Dr. Kilpi commenced his studies at the University as a geographer and on studying this subject he perceived the manifold and partly untouched subjects of investigation offered by the sister science — Quaternary geology.

Being as he was firmly attached to the nature of Karelia his investigations in Quaternary geology were directed, under the leaderschip of Professor Matti Sauramo, to this landscape area, first to Ladoga Karelia and later on to the provinces east of Lake Oulujärvi along the Sotkamo Drainage Basin. Also this period of investigation gave plenty of results. Thus, the Karjalainen Osakunta (Union of Karelian Students) awarded him their first prize for a paper on the subject of the late-Glacial development of Ladoga Karelia. The investigations of the Sotkamo area appeared as a thesis (»Das Sotkamo-Gebiet in spätglazialer Zeit»), which is an excellent specimen of the application of the newest Quaternary-geologic methods. In this thesis he gives an exact picture of the signs produced by the water surface of ancient times, fixing their age by the aid of the varved clays as well as by means of pollen analyses and the diatoms. This resulted in a very well-written, clear, and perfect scientific investigation, and even aroused interest abroad.

Already when working at his thesis Dr. Kilpi entered the service of the Geological Survey of Finland. In the beginning he acted as Assistant Economic Geologist applying the methods of glacial geology to the tracing of glacial ore boulders. Among other things he participated with merit in the search for the Nivala nickel ore. During later years he was able to devote himself to his proper field — research in Quaternary geology.

Dr. Kilpi's scientific talent was above all based upon an unusually exact faculty of observation, combined, at the same time, with the ability — so indispensable to a researcher — of seeing things in their mutual origin associations and presenting them in a clear, easy manner. His talent was also versatile and adaptable. In the service of the Geological Survey Dr. Kilpi spent the greater part of his time in attending to practical geological questions, *i. a.* by instructing, by means of press articles and correspondence, country folks in the observation of and search for ore boulders. Besides his tasks in economic geology, he also completed his thesis by spending evenings and nights at it — a fine triumph of perseverance.

After his thesis Dr. Kilpi had time to devote himself to investigations of morainic drift, in which he was specially interested, but the outbreak of War interrupted these investigations almost at their start. Also in Finland the War drew attention to the production of peat. The Geological Survey began to organize an inventory of peat bogs and there was time to utilize Dr. Kilpi's versatile faculty in the starting of this important task also.

Dr. Kilpi's sense of duty and willingness to serve made it easy for him to manage the manifold tasks with which he was entrusted, though the latter at times hindered him from concentrating all his inner force on his proper scientific work. On the other hand, these many tasks brought him into close contact with the members of our corps of geologists. By means of this intercourse his sunny frame of mind — full of humour — was spread among those with whom he came in contact. Laughter in his company relieved one and he could coax it forth even in serious situations. Dr. Kilpi's circle of friends was extensive and even he himself enjoyed that sincere friendship, which he gave so abundantly to his fellow men.

Dr. Kilpi's sense of duty and manly honour was specially perceptible at the time when his native country demanded of him the greatest sacrifice that a man can make. Already at the time of the Winter War he, only partially trained as a soldier, got himself transferred — almost by the use of force — to the Kuhmo Front as an ordinary infantry private. However, the War ended before he had time to get to the actual front line. When War broke out again in the summer of 1941 he had already become an officer in the reserve, although for reasons of health he need not have undergone this training. The present writer knows how Ensign Sampo Kilpi, in spite of all hindrances, again got himself transferred to the front, also this time to North Finland.

Also there he had time to acquire a circle of friends, who admired him as a fearless officer and as the best of war comrades. The mind of the man did not betray him even when he, severely wounded, sent his last greetings to his dear ones and to his friends, clearly comprehending that the fight had ended as far as he was concerned.

The comradeship of war, matured in a hard school, bears up the memory of Dr. Kilpi above all that quickly changes and disappears. The bricks that he, as a researcher, had time to lay in the building of true science remain, humanly speaking, as his permanent memorial and give to us who grieve a consolatory feeling of his constant presence.

Esa Hyyppä.

LIST OF THE PUBLISHED WORKS OF SAMPO KILPI:

1. Piirteitä Karjalan synnystä. Karjala II. Karjalaisen Osakunnan Kalevalan 100-vuotisjuhlajulkaisu. 1935. Pp. 139—159. (Finnish)
2. Das Sotkamo-Gebiet in spätglazialer Zeit. Bull. Comm. géol. Finlande N:o 117. 1937. 118 pages. (Thesis for the degree of Ph. D.)
3. Sotkamonreitin alue myöhäisglasiaalikaudella. — The Late-Glacial Development of the Sotkamo Drainage Basin (The S. E. Part of the Province of Kainuu). Terra 51: 2. 1939. Pp. 109—130.

Dr. Kilpi has also published numerous press and other articles on economic and practical geology.

Erkki Rosendal

Lieutenant Erkki Magnus Rosendal, Student of Geology, was wounded in the battle of Tornio on October 3rd, 1944, and died of his wounds at Umeå, Sweden, on November 9th, 1944.

Erkki Rosendal was born at Oulu on August 3rd, 1918. From 1937 onwards he studied natural sciences at the University of Helsinki, specializing in Quaternary geology, towards which his bent and interest were specially directed. During several summers he participated in field work in Quaternary geology.

Suomen Geologinen Seura. N:o 18. Geologiska Sällskapet i Finland.

1.

ENTGEGNUNG AUF ASTRID CLEVE-EULERS AUFSATZ »DIE DIATOMEEN ALS QUARTÄRGEOLOGISCHE INDIKATOREN»

VON

KARL MÖLDER

In der Zeitschrift Geol. Fören. Förh., Bd. 66, Heft 3, 1944, Stockholm hat Dr. Astrid Cleve-Euler meine Arbeiten »Rezente Diatomeen in Finnland als Grundlage quartärgeologischer Untersuchungen» und »Studien über die Ökologie und Geologie der Bodendiatomeen in der Pojo-Bucht» so missweisend kritisiert, dass ich gezwungen bin, der Verfasserin zu antworten, um ihre falschen Vorstellungen über meine Untersuchungsergebnisse und meine Diatomeenbestimmungen zu berichtigen. Es ist mir in höchstem Masse unangenehm, der langjährigen Diatomeenforscherin im Rahmen eines wissenschaftlichen Disputs entgegenzutreten, hat sie doch ihre erste Diatomeenuntersuchung schon im vorigen Jahrhundert veröffentlicht, während ich erst etwas über zwanzig Jahre Diatomeen untersucht habe und von Dr. Cleve-Euler daher auch als junger Forscher tituliert bin. Allein die Verfasserin hat bei dieser Kritik derart grobe Fehler gemacht, dass ich nicht schweigen kann.

Die Verfasserin schreibt auf Seite 383: »Der zitierte junge Forscher hat sich wohl nicht eine hinreichend eingehende Kenntnis von früheren Errungenschaften auf dem Gebiete verschaffen können, wie seine unzulängliche geschichtliche Übersicht a. a. O. dartut.»

Meine beiden obengenannten Untersuchungen stellen ökologisch-geologische Arbeiten dar, und deshalb habe ich darin selbstverständlich nur die ökologische und geologische Diatomeenliteratur berücksichtigt. Alle rein systematischen Arbeiten wurden nur soweit benutzt, wie ich sie bei meinen systematischen Diatomeenbestimmungen benötigt habe.

Was aber Dr. Cleve-Euler mit ökologischen Arbeiten versteht, das sehen wir am besten aus ihrer Äusserung auf Seite 384: »Dass die Verhältnisse hinsichtlich unserer Kenntnis der Ökologie der baltischen Diatomeen nicht so schlecht liegen, beweist eine bereits im Jahre 1882 gedruckte kleine Abhandlung von Juhlin-Dannfelt: ‚On the Diatoms of the Baltic Sea', mit einer Menge wertvoller Beobachtungen über die im Baltikum lebenden Assoziationen und ihre Abhängigkeit von bestimmten ökologischen und lokalgeographischen Faktoren».

Ich habe die von Dr. Cleve-Euler zitierte Untersuchung von Juhlin-Dannfelt nochmals gründlich durchgesehen, habe aber zum Unglück darin gar keine Angaben über die Ökologie der Diatomeen finden können. Nach den jetzt gültigen Begriffen ist diese Untersuchung rein systematisch, mit Fundortsangaben neben Grössenangaben der Diatomeenarten. Wenn Dr. Cleve-Euler meint, dass derjenige Teil (S. 5—13), wo der Verfasser über die Geschichte der Ostseeforschung schreibt, die vermeintlichen Angaben über die Ökologie der Diatomeen enthalten soll, dann hat sie diesen Teil nicht gründlich gelesen.

Dr. Cleve-Euler schreibt weiter: »Als nächsten Schritt auf dem Wege zur Erforschung der Ökologie nordischer Diatomeen sind verschiedene Erörterungen Cleve's bezüglich des Auftretens und Vorkommens einer Reihe von finnischen Diatomeen zu erwähnen, die für kalte Wohnstätten, oder für ein salziges Medium, oder für die Oberfläche von grösseren Seen (d. h. für ein planktisches Leben; der Planktonbegriff war damals noch nicht geschaffen) kennzeichnend und in der Regel an solche Bedingungen gebunden sind. Sie finden sich in Cleve's Zusammenstellung aller damals bekannten Diatomeen aus Finnland: 'The Diatoms of Finland' 1891.»

Auch diese oben zitierte Arbeit P. T. Cleves war mir schon vor zwanzig Jahren sehr gut bekannt und ich habe sie bei meinen systematischen Untersuchungen dauernd angewendet. Dass aber Dr. Cleve-Euler diese Untersuchung zu den ökologischen Arbeiten gerechnet hat, ist ein Musterbeispiel davon, dass die Verfasserin die neueste Literatur nicht gelesen hat und dass sie keinen Begriff davon hat, was man in der Wissenschaft unter Ökologie versteht. Es ist bedauerlich, dass Dr. Cleve-Euler in der wissenschaftlichen Entwicklung auf dem Standpunkt des vorigen Jahrhunderts stehen geblieben ist und die neuere Literatur nicht verfolgt hat, sonst könnte sie mit ihrer grossen Energiemenge der Diatomeenforschung Skandinaviens verdienstvolle Leistungen hinterlassen. Das ist noch keine Diatomeenökologie, wenn P. T. Cleve (1891) in seiner Untersuchung schreibt, dass einige Diatomeen im Brackwasser und andere wieder im Salzwasser vorkommen, ohne dass er die Salzkonzentrationen des Wassers angibt. Übrigens sind diese im vorigen Jahrhundert erzielten Ergebnisse, als die Untersuchungsmethoden noch mangelhaft waren, nicht mehr völlig mit den neuesten Untersuchungsresultaten vereinbar.

Auf Seite 385 schreibt Dr. Cleve-Euler über P. T. Cleves oben zitierte Arbeit: »Endlich wird eine für 'grössere Seen' kennzeichnende Planktonflora skizziert, mit *Tabellaria fenestrata, Melosira granulata* (hier *M. islandica), Fragilaria capucina, Asterionella formosa (A. gracillima), Stephanodiscus astraea* und *Cyclotella comta* v. *radiosa* als herrschenden Arten.»

In meiner Arbeit von 1943 (a) habe ich gerade durch Untersuchungen bestätigt, dass diese Einteilung der Diatomeen in Grosssee- und Kleinseeformen in dem Sinne, wie es die Diatomeespezialisten und Quartärgeologen getan haben, nicht berechtigt ist. Auf den Seiten 207 und 208 gebe ich die Fundorte der *Asterionella formosa* (fälschlich von Dr. Cleve-Euler als *gracillima* bestimmt) aus Finnland an und am Ende des Fundortsverzeichnisses habe ich, wie folgt, geschrieben: »Aus diesen Fundortsangaben ist recht deutlich zu ersehen, dass *Asterionella formosa* in Finnland in den grösseren und auch kleineren Seen sehr verbreitet ist. Auch kann man diese Diatomee in den Flüssen und sogar in den Bächen finden, und bei der Untersuchung der Verbreitung dieser Art konnte ich bemerken, dass ihr Individuenreichtum nach dem Norden langsam abnimmt. In Estland tritt sie noch reichlicher als in Finnland auf; man findet sie dort beinahe in allen Flüssen, Bächen, Seen und grösseren Wassertümpeln, bisweilen sogar massenhaft vor (Mölder 1938, S. 14).» Ähnlich habe ich bezüglich sämtlicher anderen Diatomeen, die bisher von P. T. Cleve, Astrid Cleve-Euler, Halden, Brander, u. a., zu den Grossseeformen gerechnet wurden, festgestellt, dass diese Arten keine Grossseeformen sind und beinahe in allen Wasserbecken verbreitet sind. Wie sollte ich dann die falschen Ergebnisse der älteren Diatomeenspezialisten Skandinaviens ohne Kritik verwenden, wie das Dr. Cleve-Euler von mir verlangt?

Meine oben zitierte Untersuchung war schon im Jahre 1939 druckfertig, konnte aber wegen des Krieges erst im Jahre 1943 veröffentlicht werden. Nach dem Jahre 1939 habe ich recht viele Diatomeenproben aus verschiedenen Gewässern Finnlands untersucht und unbestreitbar feststellen können, dass wir über Grossseeformen nicht in dem Sinne reden können, wie das die älteren Diatomeenspezialisten und nach ihnen die Quartärgeologen getan haben. Will man die Diatomeen zur Feststellung vorzeitlicher grösserer Gewässer verwenden, dann muss unbedingt der Individuenreichtum der Arten berücksichtigt werden.

Dann schreibt Dr. Cleve-Euler noch weiter, dass P. T. Cleve (1891) in seiner Arbeit eine Gruppe von Arten erwähnt die nur nördliche bzw. alpine Gegenden zu bewohnen scheinen. Diese Cleveschen Angaben sind heute bereits veraltet, und neuere Untersuchungen haben erwiesen, dass viele Arten, die der Verfasser als »nordische» aufgezählt hat, auch in südlichen Gegenden gedeihen. So konnte ich z. B. *Caloneis obtusa* (W. Smith) Cleve (*Navicula hebes* Ralfs) in Südestland im Flusse Ahjajögi bei Taevaskoda feststellen.

Auf Seite 385 schreibt Dr. Cleve-Euler, dass im nördlichen Teil des Bottnischen Meerbusens das Wasser ausgesüsst wird und man deshalb nicht *Brébissonia Boecki* und *Campylodiscus*-Arten dort finden kann. So verhält es sich aber in Wirklichkeit nicht. Diese fehlerhafte Vorstellung hat die Verfasserin wahrscheinlich deshalb erhalten, weil sie vielleicht keine Proben oder dann sehr wenig Material vom östlichen Ufer des Bottnischen Meerbusens untersucht hat. In meiner Untersuchung (1943 a, S. 181) habe ich über die Brackwasserdiatomeen bei der Stadt Kemi folgendes geschrieben: »Von Brackwasserdiatomeen sind insgesamt 15 Arten und Varietäten vorhanden, d. h. 10.7 % aller Diatomeen, die bei Kemi gefunden worden sind. Auch unter diesen Arten sind die meisten nur von einer Stelle bekannt und zeigen dadurch, dass sie hier nicht günstige Wachstumsbedingungen gefunden haben. Solche Arten sind z. B.: *Achnanthes Hauckiana, Amphora commutata, Brébissonia Boecki, Mastogloia Smithii* mit ihren Varietäten und andere.» Wie schon aus dem Obigen hervorgeht, können die Brackwasserdiatomeen bei der Stadt Kemi nur sehr schlecht gedeihen. Dass wir es dort mit rezenten Diatomeenfunden zu tun haben, konnte ich im Mikroskop selbst feststellen, denn alle Exemplare enthielten grüne Chloroplasten und bewegten sich in frischem Material im Präparat. Seitdem habe ich während der letzten Jahre Diatomeenproben aus dem Bottnischen Meerbusen bei den Städten Oulu, Raahe, Kokkola, Vaasa, Kristiina, Rauma und auch von mehreren anderen Stellen gesammelt, und in allen diesen Proben konnte ich *Brébissonia Boecki* mit grünem Chlorophyll feststellen. Wenn aber Dr. Cleve-Euler behauptet, dass die obengenannte Diatomee in dem Bottnischen Meerbusen nicht vorkommt, nun, so muss wohl von mir eine falsche Bestimmung vorliegen. Um Dr. Cleve-Euler nicht im Zweifel darüber zu lassen, dass ich *Brébissonia Boecki* nicht kenne, habe ich diese Diatomee aus einer Probe von der Stadt Kemi mit dem Zeichenapparat abgezeichnet; diese Zeichnung ist in Abb. 1 wiedergegeben. Die Zellen waren zum grössten Teil 60 bis 130 μ lang und 20 bis 24 μ breit. Wie man aus diesen Grössen sieht, sind die Zellen bei der Stadt Kemi am oberen Ende der Skala etwas kleiner, als die von Hustedt in seiner Diagnose angegebene Zellengrösse. Dieser Unterschied ist durch die verschiedenen ökologischen Wachstumsverthältnisse bedingt. Wie aus diesen Grössenangaben leicht zu ersehen ist, und wie gleichfalls aus Abb. 1 hervorgeht, haben wir es mit einer *Brébissonia Boecki* zu tun, deren Grösse und Habitus mit der Diagnose wohl gut übereinstimmt. Was aber die *Campylodiscus*-Arten betrifft, die gleichfalls nach Dr. Cleve-Euler nicht im Bottnischen Meerbusen

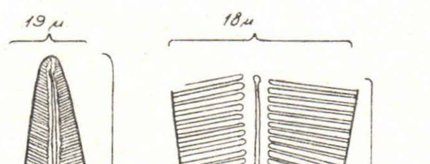

Abb. 1. *Brébissonia Boecki.*

vorkommen, so konnte ich auch diese Arten hier und da am Ufer und *Campylodiscus echeneis* häufig auch im Plankton vorfinden.

Aus Cleve-Eulers Aufsatz geht noch die sehr interessante Tatsache hervor, dass die Verfasserin fast sämtliche in den Seen Finnlands vorkommenden Diatomeen, die nicht mit ihren eigenartigen Theorien zusammenpassen, zu den Subfossilien gerechnet hat. Es ist möglich, doch erstaunlich, dass die Verfasserin die Diatomeen vor der Anfertigung der Dauerpräparate nie im lebenden Zustand durchgemustert hat, sonst hätte sie nie solches geschrieben, d. h. rezente Diatomeen ohne Untersuchung zu den subfossilen Formen gerechnet. Ich habe die rezenten Diatomeenproben vor der Anfertigung der Dauerpräparate stets unter dem Mikroskop durchgemustert, um festzustellen, ob die Diatomeenschalen grüne Chloroplasten enthalten oder nicht. Ausserdem habe ich die Diatomeenproben für meine genannte Untersuchung von 1943 (a) bei der Stadt Helsinki und bei der Stadt Kemi zum grössten Teil von Steinen, Pfählen, Holzstücken und im Wasser wachsenden höheren Pflanzen abgekratzt, wo Subfossilien doch wohl auch nach Dr. Cleve-Euler gewöhnlich nicht zu erwarten sein dürften.

Zusammenfassend kann gesagt werden, dass die von Dr. Cleve-Euler als ökologische Untersuchungen angeführten Arbeiten, zu denen sie auch ihre eigenen gerechnet hat, überhaupt keine ökologischen Arbeiten sind, und dass die Verfasserin also mit ihrem Angriff gegen meine Literaturunkenntnis ganz vorbeigeschossen hat, oder richtiger gesagt, die Literatur selbst nicht so gut kennt, dass sie zwischen ökologischen und systematischen Untersuchungen zu unterscheiden vermöchte.

Auf den Seiten 392 bis 395 verteidigt die Verfasserin den einen Heldentot gefundenen Forscher Dr. G. Brander; da aber der Verteidigte selbst mir nicht mehr antworten kann, will ich an dieser Stelle nicht auf diese Frage näher eingehen und bleibe daher auch Dr. Cleve-Euler eine Entgegnung schuldig.

Besonders über meine Einteilung der Diatomeen in Halinitätsgruppen ist die Verfasserin sehr böse und schreibt, dass ich die Ergebnisse der alten skandinavischen Diatomeenspezialisten nicht ohne Kritik verwendet, dagegen mehr Hustedts Angaben in der kleinen mitteleuropäischen Flora Paschers berücksichtigt habe. Es ist sehr interessant, was die Verfasserin (S. 401) darüber schreibt: »Nun hat unglücklicherweise Dr. Hustedt seine Erläuterungen zu halinen Diatomeen in der genannten Flora derart variirt, dass er ihr Medium bald mit Salzwasser, bald mit Brackwasser bezeichnet, ohne dass damit Gewässer mit einander ausschliessenden Salzgehalten gemeint werden.»

Dann führt die Verfasserin 3 Tabellen in ihrer Arbeit vor, die zeigen sollen, dass ich die Untersuchungsergebnisse der zwei skandinavischen Diatomeenforschergenerationen nicht gewertet habe, und fragt zum Schluss (S. 403): »Wie man sieht, wird diese sonderbare Gesellschaft einzig und allein durch die Hustedtsche Charakteristik zusammengehalten. Warum den schon vor ihm gesammelten Wissenschatz so vollständig übergehen?»

Wie ich schon in meiner Untersuchung (1943 a, S. 152) angeführt habe, wurden die Diatomeenproben für dieselbe in den Jahren 1935 bis 1937 gesammelt, während die Arbeit selbst im Jahre 1939 druckfertig wurde und ihre Veröffentlichung wegen des Krieges sogar bis auf das Jahr 1943 verschoben werden musste. Damals waren meine eigenen Erfahrungen über die Salzwasser- und Brackwasserdiatomeen noch recht mangelhaft, und darum habe ich mich auf die Untersuchungsergebnisse der älteren Diatomeenspezialisten, darunter auch der von Dr. Cleve-Euler zitierten: v. Heurck, Östrup, Cleve, Grunow, Hustedt u. a., recht viel berufen. Diese früheren ökologischen Kenntnisse habe ich nur soviel korrigiert, wie ich auf Grund meiner eigenen Untersuchungen feststellen konnte, dass die älteren Angaben nicht stichhaltig waren. Auf Grund meiner eigenen Untersuchungen und auch aus der Literatur konnte ich konstatieren, dass die Bezeichnungen in den älteren Untersuchungen — »Salzwasser», »Brackwasser» usw. — häufig nicht mit den neuesten Untersuchungsergebnissen übereinstimmten. Da aber Dr. Hustedt in seiner Arbeit auch die neueste Literatur beachtet hat, stimmten eben seine Angaben am besten mit meinen eigenen Untersuchungsergebnissen überein. Dasselbe hat Dr. Cleve-Euler auch selbst in ihren Tabellen 1 bis 3 bestätigt, und ich kann nichts dafür, dass die Untersuchungsmethoden in den letzten Zeiten dermassen grosse Fortschritte gemacht haben, dass man heute viel genauere Resultate erzielt.

Um mich namentlich deshalb so streng und unrichtig kritisieren zu können, dass ich die Untersuchungsergebnisse der Verfasserin selbst nicht berücksichtigt habe, hat sie die Tabellen 1 bis 3 ihres Aufsatzes so zusammengestellt, dass sie aus meinen Tabellen nur diejenigen Arten herausgegriffen hat, die mit den Resultaten Hustedts übereinstimmen, und alle diejenigen ausgelassen hat, die mit den Hustedtschen Ergebnissen nicht übereinstimmen. Dass ich recht habe, geht am besten aus folgenden Worten Dr. Cleve-Eulers hervor: »Von einer ökologischen Feinsichtung des Algenbestandes in diesem Sinne sind wir immer noch weit entfernt und können vorläufig die gesammelten, wenngleich mehr allgemein ausgedrückten Erfahrungen der älteren nordischen und im Norden tätigen Forscher nicht entbehren.»

Inzwischen hat aber die Limnologie, welcher auch die Diatomeenuntersuchung eigentlich zufällt, grosse Fortschritte gemacht, und die Untersuchungsmethoden aus dem vorigen Jahrhundert sind heute bereits nicht mehr gültig. E s w u n d e r t m i c h s e h r, d a s s d i e V e r f a s s erin selbst nicht verstehen kann, dass die neueren Untersuchungsmethoden viel besser sind und auch richtigere Resultate als die veralteten Methoden liefern, deren sie sich bei ihren Untersuchungen stets hartnäckig bedient. Es ist schade, dass es alte Wissenschaftlerinnen gibt, die die Entwicklung der Wissenschaft dermassen zu bremsen versuchen, denn so kan sich die wissenschaftliche Untersuchung nie weiterentwickeln.

Um den Wert meiner Untersuchungen und die Zuversicht zu denselben niederzureissen, beschuldigt Dr. Cleve-Euler mich am Ende ihres Aufsatzes falscher Diatomeenbestimmungen, und das ohne dass sie meine Diatomeenpräparate selbst gesehen oder je in ihrem Leben Diatomeenproben aus den betreffenden Gegenden untersucht hat. So darf man doch nur dann machen, wenn man selbst die Diatomeenflora jener Gegenden gründlich kennt oder wenn die Diatomeenflora Finnlands im übrigen gut bekannt ist. So ist es aber nicht. Dr. Cleve-Euler hat selbst nur wenige Proben (über 100) aus Nordfinnland gesammelt und untersucht und die Resultate in zwei Arbeiten (1934 und 1939) niedergelegt. Ausserdem hat sie fossile und subfossile Diatomeen aus anderen Teilen Finnlands untersucht, und ferner sind noch einige Untersuchungen erschienen, in denen Diatomeen behandelt worden sind. Aber es fehlen jegliche Arbeiten über die Uferdiatomeen des Finnischen Meerbusens und der finnischen Seite des Bottnischen Meerbusens, so dass Dr. Cleve-Euler keine richtige Vorstellung über die Diatomeen jener Gegenden haben kann, wo meine obengenannten beiden Untersuchungen durchgeführt wurden. Aus dem Obigen erhellt, dass Dr. Cleve-Euler gar keine Voraussetzungen gehabt hat zu sagen, dass ich diese und jene Diatomeen falsch bestimmt habe; aber ohne jegliche Grundlagen hat die Verfasserin selbst bis in diese Zeit gearbeitet und es ist unmöglich, auch in diesem Fall von ihr eine Ausnahme zu verlangen.

Dr. Cleve-Euler beginnt ihre Darlegung über meine falschen Diatomeenbestimmungen (S. 405) folgendermassen: »Unter den Brackwasserformen Mölder's finden wir die rein marine *Melosira nummuloides*, was darauf beruhen dürfte, dass die in Wirklichkeit vorliegende *M. arctica*, auch *hyperborea* genannt, in Hustedt's Bacillariophyta nicht vorkommt. Mölder konnte hier nur *M. nummuloides* finden, und so blieb ihm die in allerlei nordischen Arbeiten über das Ostseeplankton, so z. B. in 'Nordisches Plankton' erwähnte *M. arctica* unbekannt. (Für Tvärminne wird die Art indessen als selten erwähnt.)»

Glaubt die Verfasserin wirklich, dass wir in Finnland in den Bibliotheken der Universität Helsinki und ebenso in den Bibliotheken der verschiedenen Untersuchungsanstalten und Instituten keine andere Diatomeenliteratur haben, als die von ihr zitierte kleine Diatomeenflora Paschers? Dass es glücklicherweise doch nicht so schlimm bestellt ist, geht schon aus demjenigen Teil der Äusserung hervor, den die Verfasserin in Klammern gesetzt hat: »Für Tvärminne wird die Art indessen als selten erwähnt.» Wie unlogisch ist die Verfasserin auch an dieser Stelle gegen mich vorgegangen, wenn sie zuerst schreibt, dass ich nur Hustedts Bacillariophyta gehabt habe und deshalb *Melosira nummuloides* bestimmen konnte, dann aber erst bemerkt, dass von mir *Melosira arctica* doch bei Tvärminne festgestellt worden ist, was bedeutet, dass ich auch solche Bestimmungsbücher besitzen muss, wo auch diese Diatomee aufgenommen ist! Schon daraus allein müsste der Verfasserin klar werden, dass ich *Melosira nummuloides* von *M. arctica* unterscheiden kann, dass beide Arten in den Proben aus Tvärminne zusammen vorkommen und beide auch in meiner Untersuchung (1943 b) getrennt dargestellt sind.

Es würde auch nur umsonst Platz verlangen, auf alle Dr. Cleve-Eulers Vorwürfe einzugehen. Es dürfte deshalb genügen, lediglich einige Beispiele herauszugreifen, um zu kontrollieren, wer die genannten Diatomeen falsch, wer aber richtig bestimmt hat. So schreibt Dr. Cleve-Euler auf Seite 407: »Überraschend ist endlich ein nach Mölder reichliches Vorkommen von *Nitzschia granulata*, einer Art, der ich bei Durchmusterung unzähliger finnischer Proben nur einmal, und zwar in Nivala, Österbotten, begegnet bin. Dafür fehlt aber *N. punctata* in der Mölder'schen Tabelle, und so liegt wohl nur eine falsche Bestimmung vor?»

Im Laufe meiner wissenschaftlichen Tätigkeit bin ich mehrere Jahre im Auslande (in europäischen Staaten) gewesen, zum letzten Mal in den Jahren 1940 bis 1942, und habe bei mehreren bekannten und auch anerkannten Diatomeenspezialisten gearbeitet, die auch meine Bestimmungen kontrolliert haben. Aber was lohnt es, der Verfasserin diese Tatsachen zu erklären, denn sie lebt ja doch in der Vorstellung, dass alle anderen die Diatomeen falsch bestimmen und nur sie allein sie richtig kennt (siehe A. Cleve-Euler 1942).

Zur Entscheidung, ob ich *Melosira nummuloides* und *Nitzschia granulata* falsch bestimmt habe, mögen die beigegebenen Abb. 2 und 3 aus den Diatomeenproben der Pojo-Bucht mit Hilfe des Zeichenapparats aufgezeichneten *Melosira nummuloides* und *Nitzschia granulata* darstellen. Ich habe schon längere Zeit von Dr. E. Hyyppä aus den Vereinigten Staaten mitgebrachte fossile Diatomeenproben untersucht, wo *Nitzschia granulata* recht häufig vorkommt und schon damals von Patrick in Philadephia als diese Art bestimmt wurde. Ich habe nun diese Diatomee auch mit denjenigen Formen verglichen, die ich in der Pojo-Bucht entnommen hatte, und konnte ganz überzeugend feststellen, dass die in der Pojo-Bucht vorkommende Alge *Nitzschia granulata* ist. Auch passten die Formen aus USA. und der Pojo-Bucht vorzüglich auf die Diagnose Grunows ein. Später wies ich meine Diatomeenpräparate in Deutschland den dortigen Diatomeenspezialisten vor, und auch sie konnten bestätigen, dass in der Pojo-Bucht *Melosira*

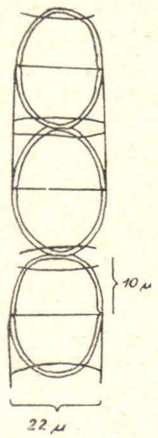

Abb. 2. *Melosira nummuloides.*

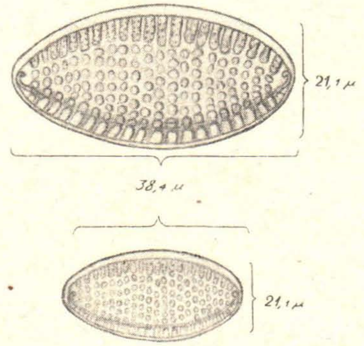

Abb. 3. *Nitzschia granulata.*

nummuloides und *Nitzschia granulata* vorkommen. Man braucht übrigens überhaupt kein Diatomeenspezialist zu sein, um schon den richtigen Sachverhalt zu erkennen.

Wenn Dr. Cleve-Euler bei der Bestimmung von *Nitzschia granulata*, einer groben und daher leicht kenntlichen Form, einen solchen Fehler machen kann, was können wir dann bei den Bestimmungen der *Thalassiosira-*, *Coscinodiscus-*, *Navicula-* und *Nitzschia*-Arten erwarten! Wahrscheinlich sind die Abbildungen in ihrer Arbeit »Coscinodisci et Thalassiosirae Fennosueciae» deshalb so schlecht gezeichnet, weil die Verfasserin dadurch ihre falschen Bestimmungen zu decken versucht. Es ist interessant in diesem Zusammenhang zu untersuchen, wie die Verfasserin selbst nordfinnische Diatomeen bestimmt hat. Ich habe hier die nordfinnischen Gewässer zum Gegenstand der Betrachtung deshalb gewählt, weil ich selbst Gelegenheit gehabt habe, aus denselben Gewässern Diatomeen zu sammeln, aus denen Dr. Cleve-Eulers eigene Diatomeenproben stammen, ferner, weil ich nicht ähnlich wie Dr. Cleve-Euler die Untersuchungen anderer Forscher kritisieren will, ohne Proben aus den entsprechenden Gegenden selbst untersucht zu haben.

In ihren zwei Untersuchungen aus Nordfinnland (1934 und 1939) hat die Verfasserin viele Diatomeen angeführt, die in diesen Gewässern in Wirklichkeit gar nicht vorkommen. Auch hat sie viele neue Arten und Varietäten beschrieben, die in systematischer Hinsicht zweifelhaft sind. Denn die Verfasserin hat sich hierbei nicht der neueren Literatur bedient. So beschreibt sie z. B. auf Seite 18 in der Untersuchung vom Jahre 1934 *Eunotia bactriana* f. *bisinuosa* als neue Form und gibt auch diese Diatomee in Fig. 7 wieder. Die Beschreibung lautet folgendermassen: »Ventral margin with two elevations corresponding to the dorsal lobes.» Betrachten wir

Hustedts Abbildungen in A. Schmidt, Atlas, Taf. 270, Fig. 30 und 31 (1911), so sehen wir, dass die von Dr. Cleve-Euler beschriebene neue Form schon im Jahre 1854 veröffentlicht und seither von mehreren Autoren festgestellt worden ist.

Über die Diatomeensystematik in den beiden zuletzt angeführten Untersuchungen der Verfasserin kann man nur staunen, denn sie bedient sich stets hartnäckig nur der veralteten und unrichtigen systematischen Einteilung des vorigen Jahrhunderts. So hat sie die Pinnularien gleich hinter die *Achnanthes*-Arten gesetzt und die Gyrosigmen in die *Navicula*-Gruppe geworfen. Aus diesen beiden Untersuchungen geht ferner genug deutlich hervor, dass Dr. Cleve-Euler die Pflanzensystematik nie beherrscht hat und auch nicht weiss, was man unter einer Art, einer Varietät und einer Form versteht. Gerade deshalb herrscht unter den Beschreibungen neuer Arten, Varietäten und Formen bei der Verfasserin ein Wirrwarr, dass auch sie selbst nach einigen Jahren ihre neue Formen nicht mehr erkennen kann. Die Abbildungen über neue Arten und Varietäten sind immer so schlecht und unrichtig gezeichnet, dass man nach diesen Abbildungen diese Diatomeen niemals identifizieren kann. Häufig konnte ich feststellen, dass die von Dr. Cleve-Euler dargestellten Abbildungen ein reines Fantasieprodukt sind und mit den in den Gewässern wirklich vorkommenden Diatomeen nichts zu tun haben.

Ich will indessen Dr. Cleve-Euler als bewährte Diatomeenforscherin selbst nicht mehr kritisieren, erlaube mir aber zu zitieren, was der beste Diatomeensystematiker unserer Zeit, Friedrich Hustedt (1942, S. 19—21) über Dr. Cleve-Eulers Untersuchungen und systematische Kenntnisse schreibt: »Neuerdings hat sich A. Cleve-Euler eigenhender mit *Rhizosolenia eriensis* beschäftigt und glaubt auf Grund ihrer Untersuchungen den Nachweis erbracht zu haben, dass diese Art mit *Rh. longiseta* durch »ziemlich lückenlose» Übergänge zusammenhänge (1940). Von besonderer Bedeutung soll dabei auch das Verhältnis der Borstenlänge zur Zellbreite sein. Ich bemerke dazu, dass es sich bei diesen beiden Formen um völlig getrennte Arten handelt, die so ausreichend differenziert sind, dass auch von 'ziemlich' lückenlosen Übergängen keine Rede ist! Aber die Arbeitsmethoden der Verfasserin sind derartig unwissenschaftlich, dass man keine anderen Resultate als fortwährende Irrtümer und Trugschlüsse erwarten kann.»

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»Am allerwenigsten ist aber A. Cleve-Euler zu einer abfälligen Kritik, zu der sie sich schon wiederholt bemüssigt gefühlt hat, berechtigt, denn ihre Arbeiten sind Musterbeispiele von falscher Methodik, Unzuverlässigkeit, von Irrtümern und falschen Bestimmungen.»

Mit dem Obigen hat Hustedt schon alles über Dr. Cleve-Euler gesagt, und es geht daraus hervor, dass die Verfasserin d e Diatomeen selbst nicht kennt und sie falsch bestimmt hat. Hier möchte ich noch hinzufügen, dass die Abbildungen in den Untersuchungen Dr. Cleve-Eulers (1934 und 1939) so schlecht sind, dass man nach diesen Abbildungen die von ihr beschriebenen neuen Arten und Varietäten nie wiedererkennen kann. So hat sie eine Menge von Umrissabbildungen dargestellt und auf Grund derselben dann die in den Arbeiten vorkommenden neuen Arten, Varietäten und Formen beschrieben (1939, Fig. 14, 32—34, 44, 49, 51, 57, 58, 60, 61 und 62). Ebenso schlecht sind auch die Diagnosen zusammengestellt, wie wir das aus folgenden Beispielen ersehen können. »*Stenopterobia arctica* n. sp. — Fig. 7. Schalen S-förmig gekrümmt, mit spitzlich auslaufenden Enden 77—95 μ lang, 4—5 μ breit. Kanälchen 5.5—6.5 auf 10 μ. Streifung nicht gesehen (= mehr als 25 Str. auf 10 μ).» Wie kann die Verfasserin verlangen, dass man nach den dargestellten schlechten Abbildungen und den noch schlechteren Diagnosen diese neuen Arten und Varietäten wiederfindet? Wie wir eben gesehen haben, schreibt sie in der Diagnose, dass sie die Streifung nicht gesehen hat, gibt aber doch an, dass mehr als 25 Streifen auf 10 μ vorkommen. Es ist interessant zu wissen, wie die Verfasserin diese unsichtbaren Streifen zählen und feststellen konnte, dass gerade über 25 auf 10 μ vorhanden sind?

Man könnte vielleicht glauben, dass die anderen Diagnosen besser geschrieben sind. Deshalb will ich hier noch ein Beispiel herausgreifen. Auf Seite 17 (*op. cit.*) beschreibt die Verfasserin *Gomphonema acuminatum* v. *hybrida* n. v. folgendermassen: »Schalen klein, zwischen der Mitte und dem fast gleich breitem Apex leicht eingeschnürt. L. 30—35 μ. B. 5—6 μ.» Das ist alles, ausser der schon oben angeführten schlechten Umrissfiguren. Diese beiden nordfinnischen Untersuchungen Dr. Cleve-Eulers sind so oberflächlich gemacht, dass man bei einzelnen Gewässern falsche Bestimmungen sogar bis zu 40 % feststellen konnte, wie z. B. beim Aapajärvi.

Es ist interessant zu betrachten, was Hustedt (1942, S. 221) über die geologischen Befunde der Verfasserin schreibt: »In den letzten Jahren hat Astrid Cleve-Euler eine Reihe von Arbeiten über Diatomeen veröffentlicht, in denen sie auch geologische Fragen berührt, und neuerdings hat sie sich sogar zum Schiedsrichter in dem zwischen B r a n d e r und H y y p p ä bestehenden Streit aufgeworfen, der über die Deutung fossiler Diatomeenfunde bei Rouhiala in Südfinnland ausgebrochen war (1940). Es ist hier nicht der Ort, auf die geologische Seite einzugehen, aber ich halte mich für verpflichtet, schon hier darauf hinzuweisen, dass die Grundlagen, von denen A. Cleve-Euler ausgeht, falsch sind, weil

1. ihre Diatomeen-Bestimmungen zu mehr oder weniger grossem Teil unrichtig sind,

2. ihre Ansichten über die Verbreitung mancher Diatomeen nicht den neuesten Forschungsergebnissen entsprechen, sondern auf veralteter Literatur beruhen,

3. ihre Auffassung über systematische Einheiten den elementarsten biologischen Gesetzen widerspricht,

4. zuweilen die Systematik von ihr für geologische Zwecke zurechtgestutzt wird.

Wenn ich hier in dieser Angelegenheit Stellung nehme, so geschieht das aus dem Grunde, weil die Geologen und Pflanzengeographen kaum in der Lage sind, die systematische Seite in den Abhandlungen der genannten Autorin zu beurteilen, und weil ausserdem A. Cleve-Euler es für nötig hält, an meinen systematischen Entscheidungen und Diagnosen in den 'Kieselalgen' in einer Weise herumzukritisieren, die jegliche tiefere Sachkenntnis vermissen lässt. Wer übrigens die Arbeiten dieser Autorin nicht kritiklos hinnehmen will, braucht nur die Diagnosen und Abbildungen anzusehen, um zu der Überzeugung zu gelangen, dass von einer gründlichen Arbeit keine Rede sein kann. Die Beschreibungen sind so dürftig, dass an keiner Stelle ein wirkliches Verständnis für die betreffenden Formen zu erkennen ist. Die Abbildungen aber sind grossenteils nur Umrisszeichnungen, zum Teil noch sogar schematisiert und sicher nicht der Wirklichkeit entsprechend; wo die Strukturen eingezeichnet sind, zeugen sie vielfach von einer bedenklichen Flüchtigkeit und sind teilweise vollkommen falsch. Ich will A. Cleve-Euler keinen Vorwurf machen, wenn sie nicht besser zeichnen kann, wer aber derartige oberflächliche Arbeiten liefert, hat nicht das Recht, gewissenhafte Arbeiten in unsachgemässer Weise zu kritisieren, und es ist im Interesse der Wissenschaft dringend zu wünschen, dass mit einem derartigen Dilettantismus, wie ihn A. Cleve-Euler in ihren letzten Abhandlungen bewiesen hat, endlich Schluss gemacht wird.»

Wie aus Hustedts Darstellung hervorgegangen ist, hat Dr. Cleve-Euler selbst recht viele Diatomeen falsch bestimmt. Wie kann man dann erwarten, dass sie über meine Bestimmungen entscheiden kann, ob sie falsch oder richtig sind? Wenn Dr. Cleve-Euler aus den Gewässern Nordfinnlands über einhundert Diatomeenproben untersucht und nach diesem Material dann zwei Untersuchungen geschrieben hat, besagt das noch keineswegs, dass sie die Diatomeenflora Finnlands gut kennt. Auf Grund dieser wenigen Gewässeruntersuchungen kann man sich noch längst nicht darüber äussern, welche Arten hier und welche dort vorkommen können.

Diese Kritik Dr. Cleve-Eulers an meinen beiden ökologischen Diatomeenuntersuchungen offenbart, dass sie gar nicht weiss, wie man wissenschaftlich arbeiten muss. Wäre sie wirklich wissenschaftlich vorgegangen, so hätte sie wenigstens meine Diatomeenpräparate durchgesehen, um eine Auffassung zu gewinnen, welche Arten in diesen Proben vorkommen können. Dann hätte sie — das ist meine volle Überzeugung — eine solche Kritik nie geschrieben und wir hätten ein Musterbeispiel von Dr. Cleve-Eulers unwissenschaftlicher Arbeit weniger zu lesen.

Zusammenfassend ist über Dr. Cleve-Eulers Kritik über meine beiden ökologischen Diatomeenuntersuchungen zu sagen, dass die Verfasserin

1. die ökologische Literatur über die Diatomeen nicht kennt und daher in ihrem Aufsatz rein systematische Arbeiten als ökologische Untersuchungen aufgezählt hat;
2. die neueren Untersuchungsergebnisse über die Halinität der Diatomeen nicht kennt, in denen konstatiert worden ist, dass in den alten Diatomeenuntersuchungen die Bezeichnungen »Salzwasserformen», »Brackwasserformen» usw. häufig falsch sind;
3. die Diatomeen selbst falsch bestimmt hat und darum auch nicht kompetent ist zu sagen, dass meine Bestimmungen falsch sind, da sie ausserdem auch meine Materialien nicht kontrolliert hat;
4. in der Diatomeensystematik nicht den entferntesten Begriff davon besitzt, was man unter Art, Varietät und Form versteht;
5. so oberflächlich gearbeitet, veraltete Untersuchungsmethoden gebraucht und falsch Diatomeen bestimmt hat, dass sie überhaupt nicht berechtigt ist, meine Untersuchungen und ebensowenig auch die Arbeiten anderer Diatomeenspezialisten zu kritisieren.

Will man die Untersuchungen anderer Forscher kritisieren, dann muss man seine Sache selbst gründlich beherrschen, richtig arbeiten und auch alle neuesten Untersuchungsmethoden kennen und verwenden. Diese Regeln erfüllt Dr. Cleve-Euler aber nicht, und deshalb ist es schade, dass sie die wissenschaftliche Literatur in Schweden mit solchen Irrtümern belasten kann.

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2.

ON THE CHEMISTRY OF THE EAST FENNOSCANDIAN RAPAKIVI GRANITES

BY

TH. G. SAHAMA

CONTENTS:

INTRODUCTION.

In his classical paper from the year 1925 Sederholm (1925) presented a review of the average chemical compositions of the most important Finnish rock groups based on analytical data available at that time. He also gave a figure for the average composition of the whole Finnish rock ground of Pre-Cambrian age. The given mean composition he regards as characteristic of crystalline Pre-Cambrian areas in general. This result was obtained by calculating an average of all analyses published of rocks of separate rock groups and by taking into account the distribution of these rock groups according to the general geological map of Finland. Though the figure of Sederholm without doubt even at present still has its full weight, it is, however, to be noted that our knowledge of the geology of the Finnish rock ground has since 1925 been greatly enlarged. Many new map sheets from different parts of the country on the scale 1 : 400 000 have been published by various authors and Sederholm has himself published an essentially completed and revised edition of the general geological map of Finland (1930). Accordingly, our knowledge of the distribution of the separate rock groups in Finland has considerably increased. In addition, it must be borne in mind that newer geological literature contains a great number of analyses representing various rock groups in Finland which, of course, provide us with a more complete picture of the chemistry of the separate rock groups than that available to Sederholm. Accordingly, a revision of the calculations of Sederholm based on the recent material is a very important task. It is therefore to be noted with satisfaction that Mr. Ahti Simonen, M. A., of the Geological Survey has taken up this work and that his results will be published in the near future.

Of the analytical material at disposal when making calculations of this kind there is, in addition to the old symposium of Hackman (1905), a newer one to be mentioned given by Lokka (1934), which contains all analyses of Finnish rocks published up to the year 1934. In this paper Lokka has not further discussed the material in question, but has merely collected it. A symposium of this kind obviously greatly facilitates the working of the petrologist in order to find out the chemical characteristics of the different parts of the Finnish rock ground. It would, however, be of considerable value to give a compendium to the collection of Lokka mentioned above and also this detail is comprized in the working programme of Mr. Simonen.

Two years later than Sederholm, Eskola (1927) published a survey on the subject. On the basis of the Niggli values calculated for the available analyses of the Finnish rocks, he gave a description of the chemical characteristics of the most important rock groups in question.

All investigations mentioned above were based exclusively on chemical analyses. Evidently, only such elements were taken into consideration which usually are determined quantitatively in the course of an analysis made for common petrographical purposes. Most of the trace elements undeterminable by ordinary chemical means or the determination of which is extremely difficult or presupposes the spending of a good deal of time have in general been left out of consideration. As pointed out by various authors, just the trace elements play, however, often as important a role in the chemical characterizing of a certain rock group as do the principal elements; often even a more important one. A complete geochemical treatment of separate rock groups or geological formations presupposes indisputably a consideration of the trace elements too. In common usage among the geologists in Finland, it has, indeed, unconsciously become prevalent to mean by a geochemical investigation proper a treatment of the trace elements only, but this is, of course, wrong in principle. A geochemical investigation deals with the main elements as well as with the minor constituents.

The applicability of the minor constituents as Pilot elements in geology and the content of trace elements in separate geological formations or rock groups in Finland have been previously treated by Sahama (1936), Sahama and Rankama (1939), Erämetsä (1938), Erämetsä, Sahama and Kanula (1941) and finally by Rankama (1944) and Sahama (1945). A great number of trace elements determinable spectrographically were taken into consideration. This whole direction of investigation, of which the papers cited above are stated as examples, is in Finland as in all other countries merely in its beginning, and it is to be hoped that in the future it will become usable as one of the working methods to help the geologist when setting up divisions for the separate rock groups in the Pre-Cambrian and when characterizing them.

In Eastern Fennoscandia the rapakivi granites form petrologically and stratigraphically one of the most coherent rock groups. According to Sederholm they cover ab. 6.0 % of the total area of Finland of that time. Therefore and because — as shown by various authors — the rapakivi granites in their bulk composition actually depart in certain respects from the granitic rocks in general, a geochemical characterizing just of the rapakivis is to be set up as one of the first tasks when going on to solve on the basis of geochemistry the special features of the different parts of the Finnish rock ground and the differences prevailing between them. In the present paper I am going to deal with the chemistry of the rapakivi granites of Eastern Fennoscandia in order to find out the special features of these rocks in relation to the other granitic rocks. With regard to the main elements, and also a number of the trace elements, this circumstance has been treated in literature and for them the problem is to be regarded as solved already. For most of the trace elements the question has not so far been the subject of investigation. In this connection it is to be emphasized that the variations of the chemical compositions in the different parts of the known rapakivi *massifs* and the regional details in general are not included in the present problem. I intend only to give a picture of the average rapakivi composition.

THE EAST FENNOSCANDIAN RAPAKIVI AREAS.

The East Fennoscandian rapakivi granites all occur in the svecofennidic zone of South Finland or in its continuation north-east of Lake Laatokka. In this zone actually five extensive areas can be distinguished (Fig. 1) close to which, in some cases, smaller rapakivi *massifs* are met with. Taken from west to east these areas are the following: 1) the Ahvenanmaa (Åland) area with the Kökar area south-east of it, 2) the Vehmaa area, 3) the Laitila area, 4) the Viipuri area and on the northern edge of it the independent Mäntyharju—Jaala *massif* and 5) the Salmi area as well as northeast of it the small Sotjärvi *massif*. Besides these areas, there is to be mentioned a sixth one situated at the bottom of the Gulf of Bothnia, from which Eskola (1928) has found boulders all along the west coast of Finland up to the vicinity of Vaasa.

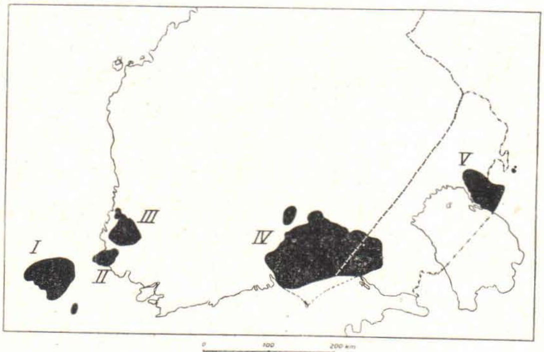

Fig. 1. The East Fennoscandian rapakivi areas. I The Ahvenanmaa area. II The Vehmaa area. III The Laitila area. IV The Viipuri area. V The Salmi area.

In the explanations to the old geological map-sheets of South Finland, published during the years 1888—1901 in the Finnish and Swedish languages by the officials of the Geological Survey, there appear short petrographical accounts of the more important rock types of the Ahvenanmaa, Vehmaa, Laitila and Viipuri rapakivi areas. In newer geological literature several investigators have territorially treated the East Fennoscandian rapakivi. A general description of the rapakivi types observed and their distribution in the Ahvenanmaa area has been presented by Sederholm (1934) while the Vehmaa area has been dealt with by Kanerva (1928). There is so far no complete presentation of the Laitila area, but Laitakari (1928) has treated the northern part of the area in regard to the contact of the rapakivi granite with its surroundings. Wahl (1925) has published a general rock description of the Viipuri area and Popoff (1928) has completed it by abundant microscopical observations. The south-western edge of the area has in addition been examined by Sederholm (1923), and Hackman (1934) has presented an exhaustive description of the northeast corner. Further, a short presentation of the rocks of the island Suursaari has been given by Kranck (1928) and of the varieties of Someri and Haapasaaret (Aspöarna) islands by Wahl (1938). Trüstedt (1907) has described to some extent the rapakivi rocks of the Salmi area situated nearest the Pitkäranta mining field. General questions relating to rapakivi in Finland have been further treated, without being confined to fixed areas, *i. a.* by Eskola

(1930, 1932) and Sederholm (1928), as well as by several Swedish investigators, for instance Backlund, v. Eckermann, *etc.*

The literature referred to above about the rapakivi granites of East Fennoscandia, which could be further supplemented by certain old investigations as well as by the brief notices made by a number of investigators in different connections, contains the picture which the petrographical and geological investigations of the rapakivi granites of the area in question are so far able to offer us. In general geological maps the rapakivi granites are even often presented in one colour only, the different varieties not being marked separately. As is already to be seen from literature presented and as every geologist, who has moved about in the rapakivi areas personally knows, the rapakivis of all the mentioned areas texturally represent types which vary considerably. The occurrence of these types is partly so local, that their marking in geological maps causes difficulties, but as, for instance, done by Kanerva (1928), in the Vehmaa area, and Hackman (1934) in the north-eastern part of the Viipuri area, the prevailing subdivision of types could be made perceptible even on the maps. Actually it is to be established that in most of the rapakivi areas a detailed modern geological mapping has not as yet been performed and this task is an essential part of the South Finland mapping programme, which through the action of Dr. Erkki Mikkola was commenced in 1936 on behalf of the Geological Survey, and which after his death has been continued principally by Mr. Kauko Parras, M. A.

When rapakivi is distinguished from the granites in the geological text- and handbooks, published in different countries, the rapakivi variety from the Viipuri area, called »wiborgite» by Wahl (1925) according to its classical place of discovery - Viipuri - is generally given as a type example. This variety is conspicuously characterized by the oval potash feldspar phenocrysts surrounded by oligoclase mantles. It is true that such a »wiborgitic» texture is a trait very characteristic just of rapakivis and of them only, but every investigator who has occupied himself with them knows quite well that it cannot be regarded as being any real definition of the texture of rapakivis in general. The whole term »rapakivi granite» is to be held as being as much a geological term as a purely petrographical one, and it is to be considered as being the common name for all the rock types of the granite areas in question.

Without touching upon closer details, the granite varieties appearing in the rapakivi areas can texturally be subdivided into the following main types:

1. The wiborgite type (Wahl). Characteristic of this type are the oval potash feldspar phenocrysts and the oligoclase mantles surrounding them.

2. The pyterlite type (Wahl). This type differs from the preceding one in that the oligoclase mantles are missing.

3. The even-grained rapakivi type. The oval potash feldspar phenocrysts are missing.

4. The granite porphyritic type. In the fine or rather coarse ground mass there are potash feldspar phenocrysts of a well-developed cryatsl shape.

These four main types all vary in the different areas and there are different varieties of them. To them are to be added also the ordinary abyssal or hypabyssal quartz porphyries (for instance at Suursaari.)

As is already to be observed from the presented type subdivision it is exceedingly difficult to give a general definition of the ordinary »rapakivi

Fig. 2. Almost even-grained rapakivi granite, the ovoidic development of the potash feldspar only slightly visible. Note the dark idiomorphic quartz grains. Ihovaara hill, Suistamo, Salmi area. (On a slightly reduced scale.)

texture». Possibly the only circumstance common to most of the granite types of the rapakivi areas, and showing so wide a distribution in the rapakivi areas that it can be held as being characteristic of the »rapakivis», is the appearance of quartz in two separate generations. The rapakivis very often contain — almost as a rule — smoky-grey dark quartz grains with well developed idiomorphic shapes and, on the other hand, in the ground mass, small shapeless and in colour lighter quartz grains. This circumstance, which is also to be observed in Fig. 2, is characteristic of the rapakivis but in general foreign to the other granites of the Finnish Pre-Cambrian. In addition, it is, however, to be mentioned that typical of all rapakivis is the complete lack of traces of any kind of movement. The contours of individual grains are plain and comparatively straight and because of that the whole texture of the rock is fairly loose.

The question as to how a rapakivi-like texture, such as it appears especially in the wiborgite, but also in the pyterlite type, is thought to have originated has in literature given rise to many kinds of explanations and explanatory attempts, but — in spite of the fact that many investigators have treated the subject — we have, however, to confess that no one has been able to present a final and exhaustive interpretation. In this connection there is special cause to refer to those observations of the appearance of a typical rapakivi-like texture in some of the younger granites in the Gardar formation in South Greenland so vividly presented by Wegman (1938). I have no knowledge of the chemistry of these rapakivis. However, the whole question of the genesis of a rapakivi-like texture in granites is a matter not really falling within the scope of this treatise. Neither is it here my intention to touch upon the mechanical crumbling so often characteristic of rapakivis, which has also all along given rise to different hypotheses and which question Eskola (1930) has last sifted.

In regard to their mineralogical composition rapakivis, however, seem to be comparatively regular, in spite of their considerable textural variations. The principal minerals are potassium feldspar (partly orthoclase, but also partly microcline) and plagioclase, the composition of the latter changing, according to the optical properties, from albite to oligoclase, as well as quartz. As dark principal minerals appear the brownish-green hornblende and biotite. To begin with hornblende, it is unfortunate that no chemical analysis has been made thereof. On the basis of the optical properties of the hornblende in numerous rapakivis of the Viipuri area Popoff (1928) considers it possible that it is an amphibole type comparatively rich in alkali and probably containing fluorine. In his previously mentioned investigation Wahl (1925) presents an old analysis, made by Struve, of the biotite found in the rapakivi of the Viipuri area and another still older, made by Svanberg. When compared to the calculation of Tschirwinsky (1928) of the average biotite composition in granites, the rapakivi biotite is found to be considerably richer in iron. This peculiarity in the biotite composition of rapakivis Wahl considers to be remarkable to such a degree that he has given a special name — »monrepite» — to biotites met with in the rapakivi; he is of the opinion that they have the same petrographical significance in the rocks of the acid potassium series as alkalipyroxenes and alkaliamphiboles in the rocks of the sodic series. I have desired to relate in this connection these facts known in regard to biotite because just biotite, obviously as the quantitatively most important dark mineral, incorporates in itself the greater or at least a rather large share of the quantity of iron met with in rapakivi. — In addition to the above-mentioned minerals Hackman (1934) has, in some rare cases, further met with hypersthene, as well as diopside and olivine (fayalite).

Of accessory minerals in rapakivi zircon and fluorite are to be mentioned first of all, their plentiful appearance being very characteristic, besides apatite, titanite and ore. Also topaz and rutile are sometimes met with as essential accessory substances. In some varieties chlorite, epidote, *etc.* have been established, but they seem to be unessential. On the other hand, it should be specially observed that no petrologist who has investigated rapakivi, has found monazite or other lanthanide minerals proper.

Taking into consideration the coarse grain of the rapakivis, the actual measurement of the quantitative mineralogical composition, for instance by planimetering, is an exceedingly difficult task. Thus, no such measurements have been presented in literature. Hackman (1934) has certainly stated the quantitative mineralogical composition of many of the rapakivis for the north-eastern part of the Viipuri area, but he has done this by calculating from the chemical analyses in question. Because of this there is no reason to touch upon them any closer in this connection.

THE SALMI AREA.

As will be perceived from the above, there are in literature more or less complete geological and petrographical descriptions of most rapakivi areas of East Fennoscandia. The available knowledge of the Salmi area is, however, very scarce and dwindles in the main to the account given by Trüstedt (1907) from that part of the respective rapakivi *massif* which lies close to the Pitkäranta mining field and, on the other hand to that given by some Russian geologists from the easternmost part of the area referred to by Timofeev (1935). The Salmi area has, besides, been investigated in the field by Ailio and Eskola, but their results are not collected in any published papers. Therefore, I will in this connection present some personal observations from those parts of the Salmi area where I have had the opportunity to move on different occasions and principally for other reasons. I am fully aware of the sparsity of my experiences as regards the area in question and, consequently, I do not intend to give any exhaustive description of the present rocks, but I hope that the scattered and incomplete observations made in the area may be to some extent able to supplement the previously known data relating to the Salmi *massif*.

The Salmi rapakivi *massif* lies on the northeast side of Lake Laatokka (Ladoga) so that the greatest part of it falls on the west side of the former frontier between Finland and Russia and only a small part of it on the east side of this border. The distribution of the rapakivi granite is shown on the map Fig. 3. The western and northern boundary of the area is known fairly completely, but the eastern one is indicated on the map only approximately due to the scarcity of exposures. The easternmost exposure known to the author is situated in the bed of the small Nälmäjoki river, running from Lake Nälmäjärvi to Lake Vieljärvi, and another one lies S.S.W. of it on the road between the villages of Palalahti and Suurmäki about 11 km S. of Palalahti. From there down to the shore of Lake Laatokka the landscape is wholly covered with quarternary deposits and the more exact establishing of the situation of the rapakivi boundary has, thus, not been carried out as yet. According to the Russian geologists, garnet gneiss has already been found at some places on the shore of Lake Kinälahdenjärvi, south-east of the village Suurmäki, indicating that the

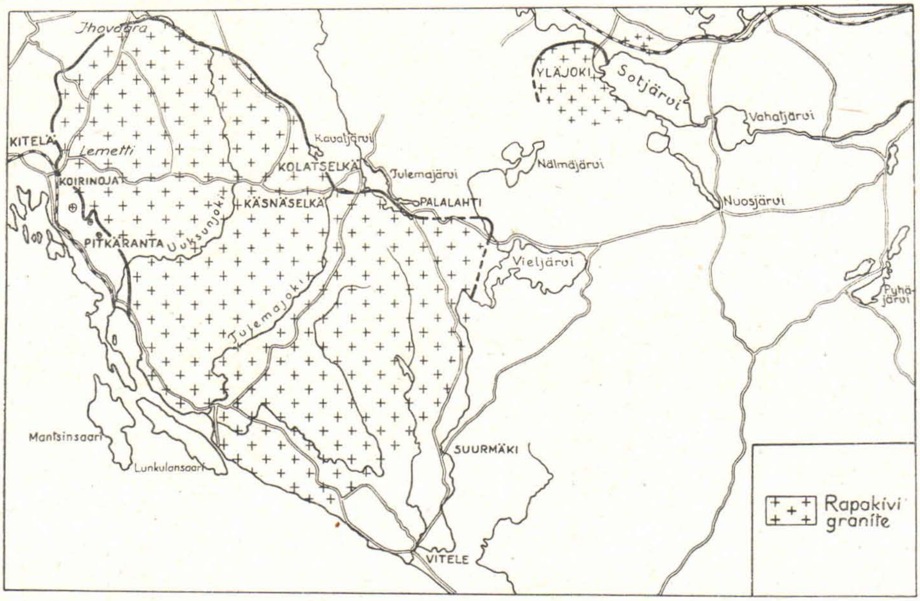

Fig. 3. Distribution of the rapakivi granite in the Salmi area.

rapakivi granite evidently does not extend farther S.E. of these tracts. It is true, that on some Russian geological maps the south-east boundary of the rapakivi area has been drawn over to the east side of Lake Vieljärvi, but this has been done only on the basis of magnetometric measurements without being supported by direct observations of exposures. Seeing that no boulders of rapakivi can be seen on the eastern shore of Lake Vieljärvi, it seems to the author that there is so far no reason to assume the distribution of the rapakivi granite area as being greater than indicated in the above figure. In the vicinity of Lake Nuosjärvi and between it and Lake Vahatjärvi and, additionally, on the main road in the vicinity of Lake Pyhäjärvi, rapakivi boulders can occasionally be found, but they can very well be derived from the small rapakivi *massif* of Sotjärvi. Due to the scarcity of exposures, the boundaries of the Sotjärvi *massif* cannot be determined with all desired accuracy. This is especially the case in the southern and south-eastern part of the area, but it is in any case certain that the Sotjärvi satellitic *massif* is an isolated one and does not lie in immediate connection with the main Salmi area. On the north side of

Lake Sotjärvi some Russian geological maps in addition show a small separate rapakivi satellite, but I have not found any exposures of it in the field.

Texturally four types of rapakivi granite can be distinguished in the Salmi area.

The first type is texturally comparable with the »pyterlitic» one of Wahl. The potash feldspar ovoids show in general a very beautiful development. Sometimes oligoclase mantles are visible around them, but the appearance of these mantles is relatively rare. In most cases the greatest part of the potash feldspar ovoids are unmantled, but among them there are some few with clearly visible mantles. The size of the ovoids amounts in general to about 5 cm. in the direction of the longest axis, but it is very often smaller and occasionally greater. In addition to the potash feldspar phenocrysts the rock is dotted with separate plagioclase phenocrysts, showing usually well-developed crystal forms. The ovoids mostly occupy the greatest part of the rock. The colour is a typical rapakivi red, but greyish varieties are occasionally met with, *i. e.*, in the vicinity of Lake Orusjärvi S.W. of Lake Tulemajärvi. The ovoidic type is dominant in the middle and southern parts of the whole area. On the main road from Koirinoja to Kolatselkä it is the most abundant type from about Lemetti eastwards and the whole area south of this road as far as to the shore of Lake Laatokka seems to be occupied thereby.

In the greatest part of the area north of the road Koirinoja—Kolatselkä and on this road west of the village Lemetti another rapakivi type is dominant. The ovoids are more or less totally lacking and the whole rock is almost even-grained, only the idiomorphic dark quartz grains being typical of a rapakivitic texture. Transitional types between ovoidic and even-grained rapakivi are not rare. The grain is mainly coarse. Mineralogically the even-grained rapakivi granite differs from the ovoidic one therein that in the former biotite represents the most abundant dark mineral, whereas in the ovoidic type hornblende plays a more important role. This circumstance is easily to be seen in the field.

In the ovoidic rapakivi a granite porphyritic variety is very often met with. It shows in general a fairly fine-grained ground mass. The potash feldspar and occasionally the few plagioclase phenocrysts lying in this ground mass have mostly an excellent crystal shape (Fig. 4). The granite porphyritic variety occurs usually only as relatively small — sometimes amounting to a few meters — spots in the ovoidic rapakivi, but in other cases it has a certain distribution over a group of neighbouring exposures. The boundaries with the ovoidic rapakivi are not sharp, but both types gradually change over to each other.

All the above mentioned rapakivi types are occasionally penetrated by veins of a fine to sometimes medium grained aplitic granite material showing no textural features characteristic of the rapakivitic granite types proper. The boundaries of these aplitic veins are often very sharp, in some

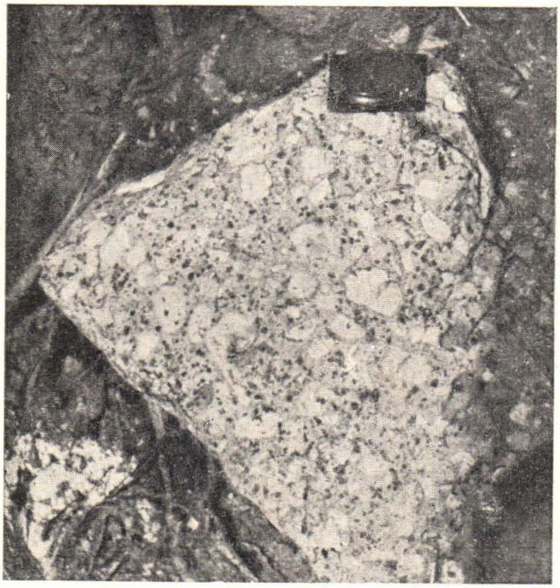

Fig. 4. Weathered surface of the granite porphyritic rapakivi variety showing the big potash feldspar phenocrysts with well-developed crystal forms. Uuksunjoki, Parish of Salmi.

Fig. 5. Beginning development of a crystal cavity in rapakivi granite. In a fine-grained granitic material there are separate spots with very coarse quartz and feldspar grains. S. of Lake Suuri Kääppäjärvi, Salmi area. (On a slightly reduced scale.)

other cases, however, they gradually change over to the normal rapakivi.

As in all other rapakivi areas, in the Salmi area too, especially in the even-grained type, but occasionally also in the ovoidic type, crystal cavities have been met with, where quartz and feldspar occur as great and often well developed crystals. In some places, *e. g.*, a couple of kilometers N.W. of the Koirinoja cross-roads one can seé how the grain size varies irregularly on a single exposure. There can be found areas amounting from a few tens of centimeters up to several meters in diameter in which the grain size regularly increases towards the centre and ends in the core in a beautiful crystal cavity. The cavity itself is often lacking. In such cases the grain is coarsened towards the core and this part of the rock appears simply as a coarse-grained lump in the rapakivi granite (Fig. 5). These

Table I. Analyses of rapakivi granites of the Salmi area. Chemica determinations by Lauri Lokka, spectrographical ones by the author.

	Granite porphyry (boulder). Uomaa.	Even-grained rapakivi granite Ab. 2 km N. W. of Koirinoja.	Ovoidic rapakivi Pensanoja.
SiO_2	75.12	76.01	70.08
Al_2O_3	12.80	12.12	15.72
Fe_2O_3	0.32	0.10	0.15
FeO	1.15	1.26	1.44
MgO	0.16	0.13	0.20
CaO	0.89	0.74	1.21
Na_2O	3.04	3.34	3.37
K_2O	5.28	5.00	6.71
H_2O+	0.61	0.33	0.50
H_2O-	0 10	0.07	0.08
MnO	0.02	0.03	0.03
TiO_2	0.23	0.16	0.28
ZrO_2	0.1	0.1	0.1
P_2O_5	0.09	0.10	0.19
F	0.20	0.25	0.18
BaO	0.081	0.038	0.14
SrO	0.005	$<$ 0.003	0.008
Rb_2O	0.10	0.09	0.12
Li_2O	0.0047	0.0052	0.0062
CoO	0	0	0
NiO	0	0	0
BeO	0.0003	0.0003	0
Ga_2O_3	0.01	0.01	0.01
PbO	0.001	0.001	0.003
B_2O_3	0.001	0.001	0.001
Cr_2O_3	0.004	0.001	0.006
V_2O_5	0.0003	0.0001	0.03
La_2O_3	0.01	0.01	0.01
Ce_2O_3	0.03	0.01	0.03
Nd_2O_3	0.006	0.006	0.006
Y_2O_3	0.003	0.003	0.003
Sc_2O_3	0.0001	0.0001	0.0001
Nb_2O_5	0.001	0.003	0.001
Sp. gr.	2.610	2.631	2.613

coarse crystal lumps evidently represent the last products of crystallization of the granite.

In order to get a view of the petrography of the rocks a selected specimen of each one of the three first mentioned types — the granite porphyritic, the even-grained, and the ovoidic one — will be described below. In Table I the respective chemical and spectrographical analyses are given. Table II contains the corresponding molecular proportions and the Niggli values. As to the analysis methods used, the reader is referred to the remarks on p. 58 regarding the Ihovaara rock analyses of Table XI.

Table II. Molecular proportions and Niggli values for the analyses of Table I.

	Granite porphyry (boulder). Uomaa.	Even-grained rapakivi granite. Ab. 2 km N. W. of Koirinoja	Ovoidic rapakivi Pensanoja.
SiO_2	1 246	1 261	1 162
Al_2O_3	125	109	154
Fe_2O_3	2	1	1
FeO	16	18	20
MgO	4	3	5
CaO	16	13	22
Na_2O	49	54	54
K_2O	56	53	71
H_2O+	34	18	28
TiO_2	3	2	4
P_2O_5	1	1	1
F	11	13	9
Rb_2O	1	1	1
si	458	503	546
al	46	43	47
fm	9	9	8
c	6	5	7
alk	39	43	38
k	0.53	0.50	0.57
mg	0.17	0.13	0.19
c/fm	0.67	0.55	0.87

Because of the comparatively coarse grain a determination of the quantitative mineralogical composition (mode) of the rocks could not be performed in the usual manner under the microscope. For a direct measurement of the actual mineralogical composition of a rock Mr. A. Kahma, M. A., of the Geological Survey, has, however, recently developed a new method, based on a statistical counting of the number of grains of a powdered sample which show a stronger refraction than a series of immersion liquids with known refractive indexes. This method, which provides a very accurate picture of the matter, is at present under final preparation by him and is not at all hampered by the coarse grain of the rock on which the determination is made. Thanks to the generosity of Mr. Kahma, I had the privilege of using this method, which he will publish in a near future. I will therefore not give any closer account of the procedure in question. The measurements needed were performed in an excellent way by Mrs. Toini Mikkola, M. A., of the Geological Survey. To both these colleagues I in this connection express my sincere thanks.

The relative proportions of the amounts of quartz and feldspars only being important for the present purpose, the dark minerals and the accessory constituents were left out of consideration and the sum of quartz and feldspars was reduced to one hundred per cent. The results of the measurements in question are given in Table III. Additionally, the corresponding amounts of these constituents calculated on the basis of the analyses given above are included in the table.

Table III. Relative proportions of quartz and feldspars in the rocks of Table I.

	Calculated on the basis of the analysis	Measured
Granite porphyry (boulder), Uomaa:		
Quartz + Oligoclase	51.5 %	53.5 %
Microcline	29.5	26.0
Albite	19.0	20.5
Even-grained rapakivi granite, ab. 2 km NW of Koirinoja:		
Quartz + Oligoclase	43.0 %	44.0 %
Microcline	27.5	39.0
Albite (with 4—5 % An)	29.5	17.0
Ovoidic rapakivi, Pensanoja:		
Quartz	26.5 %	31.0 %
Microcline	39.0	53.0
Oligoclase	28.0	9.5
Albite	6.5	6.5

One of the most important benefits obtained by the method of Kahma used above is in the present case the fact that it allows a separate determination of the amounts of all feldspars of the rock. As previously known, the rapakivi granites contain two kinds of plagioclases, *viz.*, an albite or an albitic plagioclase occurring as perthitic streaks in potash feldspar and, on the other hand, an oligoclase occurring as separate grains or occasionally as mantles around the potash feldspar ovoids. The composition of the oligoclase determined by Mrs. Mikkola with the universal stage according to the method of Reinhardt was as follows for the three rocks:

Uomaa rock	20—22 % An
Koirinoja rock	26—29
Pensanoja rock	ab. 15

In all samples the potash feldspar has been stated to be microcline.

The method used above being based solely on observations of the refraction of grains, discernment of quartz and oligoclase was not possible for the Uomaa and Koirinoja rocks, where the oligoclase has a composition of 20—30 % An. Accordingly, only the sum of both can be given.

When comparing the calculated and measured figures in Table III with each other it is first seen that the respective figures for the Uomaa granite porphyry show a comparatively good agreement. In contrast thereto, the figures for microcline and albite of the Koirinoja rock and those for microcline and oligoclase of the Pensanoja rock deviate considerably from each other. It is, however, very remarkable that the sum of the amounts of both constituents is very nearly the same in the calculated and in the measured results. The amounts of microcline are in both rocks much smaller in the calculated values than in the measured ones.

How the deviations pointed out above are to be explained does not seem to be quite clear. I have discussed the phenomenon with Mr. Kahma and at present we both agree in the opinion that the cause of these deviations can be sought neither in an inaccuracy of the calculations nor in an error in the measurements, but must have a real basis. The matter might very well be understood if we assume that the microcline of the respective rocks is not a pure potash feldspar, but instead considerably sodic. Taking into consideration that the method used allows us to distinguish between the potash feldspar proper and its perthitic albite streaks, the sodium content of the potash feldspar had to be in its own lattice as an isomorphous mixture. According to the calculations presented by Tschirwinsky (1928), the potash feldspars of granitic rocks show on an average about 12 mol. per cent albite. According to Table III the respective content of albite in the microcline of the Koirinoja and Pensanoja rocks must be considerably higher. This assumption — which at present cannot be regarded as being more than a mere assumption — can obviously not be proved analytically, because it is not possible to get a pure sample of the potash feldspar in which the perthitic streaks are entirely absent. On the other hand, the possibility that the microclines of the rocks in question are exceptionally rich in albite component is a very interesting circumstance which, if it could be proved, would be exceedingly characteristic of these rocks. However, the whole phenomenon lies beside the purpose of the present paper and therefore I will not continue the discussion of it any further. I have only wished to use the opportunity to point out that the composition of the potash feldspar of the rapakivi granite samples investigated might be of a certain interest and in any case seems worthy of special treatment by optical, X-ray, and other methods.

As to the dark minerals, biotite was established in all three samples, hornblende, however, only in the Uomaa and Pensanoja rocks. In the last-named, the Pensanoja rock, it is more abundant than biotite. The index of refraction of the biotite of the Koirinoja rock was determined by Mrs. Mikkola with the result $\gamma \sim \beta = 1.699$, showing that this biotite, in accordance with the statement of Wahl mentioned above (p. 21), represents a type called annite by Winchell in his »Elements of Optical Mineralogy». Of the accessory constituents fluorite, zircon, apatite, and ore were found. In the Pensanoja rock there exists a yellowish-brown alteration product showing good crystal form with prismatic shape, which is possibly an alteration product of fayalite.

AVERAGE RAPAKIVI COMPOSITION IN EAST FENNOSCANDIA.

EARLIER DATA.

Without touching any further upon the older investigations, dealing with the chemical composition of rapakivis, published by Struve in 1863, Lemberg in 1867 —68, Sederholm in 1891 and Hackman in 1905, and cited by Wahl (1925) in detail and critically utilized by him, it seems to be sufficient for the present purpose to note the surveys in regard to the chemistry of the rapakivi granites published simultaneously in 1925 by Sederholm (1925) and Wahl *(l. c.)*.

In his investigation Wahl first surveys the analytical material relating to the rapakivi granites of East Fennoscandia which was available in 1925. From this material he chose the analyses, which, in all probability, corresponded to modern demands upon the completeness and reliability of an analysis, and rectified the obvious inaccuracies earlier occurring in their presentation, besides publishing a new reliable analysis executed by R. Mauzelius. By this means he had at his disposal three reliable analyses of typical pyterlitic rapakivi from the Viipuri area and one analysis of the Pitkäranta rapakivi from the Salmi area, texturally resembling pyterlite, as well as one reliable analysis of typical wiborgitic rapakivi from the Viipuri area. Besides these, Wahl presents for the sake of comparison some less reliable analyses of the different rocks of the rapakivi series.

In the results of Wahl the most important circumstance worth noting in this connection is the difference, discovered by him, in the chemical composition of typical pyterlite and wiborgite. As shown by him, wiborgite distinctly contains more CaO, Na_2O and Al_2O_3 than does the pyterlitic rapakivi. In wiborgite the iron content is also slightly higher. On the other hand pyterlite is considerably richer in silica. These differences in the chemistry of both rapakivi varieties make comprehensible the more abundant appearance of oligoclase mantles in the wiborgite as well as, on the other hand, a slightly larger amount of mica in it. Wahl even presents both the mentioned rapakivi variations — pyterlite and wiborgite — as separate differentiation products from rapakivi magma and remarks that they both obviously represent in their composition comparatively regular and widely spread rapakivi types, for the average composition of which he presents the Niggli values given in Table VII on page 36. By this means a fixed rapakivitic texture as well as, on the other hand, the bulk composition of the rock have been connected with each other in the areas concerned. It is true that the analysis material at hand was numerically relatively small but the subdivision of individual rapakivi compositions between both the types mentioned was regular to such an extent that Wahl gives to the terms »pyterlitic» and »wiborgitic» rapakivi not only a textural but also a chemical meaning.

On the other hand, Sederholm, in his investigation dealing with the average composition of the rock ground of Finland — mentioned above in the introduction — presented an average calculation of rapakivis as a separate rock group (Table VI, page 36). According to Sederholm this calculation was executed on the basis of nine analyses at his disposal, the majority of which are to be considered as reliable, but he does not give a list of the analyses used. He considers a high SiO_2 and K_2O percentage as well as a low MgO, Al_2O_3, and CaO percentage to be characteristic features of the rapakivi granites.

The analysis material at the disposal of Wahl and Sederholm was condensed and besides in so far incomplete that the analyses concerned did not contain determinations of such accessory components as F which — as, for instance, in Finland Eskola (1928) stresses — is so characteristic of rapakivi granites that its absence from the corresponding analyses essentially decreases the value of the analysis. As seen from the earlier presented survey, a considerable number of complete and reliable analyses of rapakivi granites of different areas have been given in literature after the publication of the investigations of Wahl and Sederholm. By collecting them together it is thus possible to create a much more complete picture than before of the chemistry of the East Fennoscandian rapakivi granites.

Such a summary of the chemistry of the rapakivi granites of East Fennoscandia not having been carried out so far, I have in the following collected together all the old as well as newer analyses of the rocks in question known to me, which can be looked upon as being sufficiently reliable for the purpose. These analyses are presented in Table IV and the Niggli values calculated for them in Table V. I have omitted from the table all the analyses which, for some reason or other, obviously have to be regarded as less reliable, or which do not represent ordinary normal rapakivis, but their pegmatitic and other exceptional variations. Further, I have corrected in some older analyses the inaccuracies mentioned by Wahl. On examining the analyses, and on considering the conclusions drawn on the basis of them one still has to consider the four new rapakivi analyses of the Salmi area, given in the present paper (all the three analyses in Table I as well as Anal. V in Table XI). Besides the analyses presented here it must finally be noted that Mr. A. Kahma has made some individual rapakivi analyses for his treatment of the northern parts of the Laitila area, but as his investigation has not yet been published I have not wished to observe his analyses here.

As the reader will perceive on examining Table IV, only the acid members of the rapakivi series have been noted therein. For instance, the analyses of the rocks belonging to the rapakivi series of the Someri and Haapa-

Table IV. Analyses of the East

No.	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O
The Ahvenanmaa area.								
1	70.56	12.27	2.74	2.93	0.65	1.87	3.20	4.92
2	77.35	11.08	1.28	0.50	0.22	0.39	2.84	5.42
The Gulf of Bothnia area.								
3	74.51	12.12	0.62	1.87	0.04	0.94	2.53	5.97
The Vehmaa area.								
4	68.03	12.78	1.60	4.90	0.28	2.49	2.86	4.95
5	71.21	12.09	0.80	3.89	0.12	1.61	3.39	5.10
6	71.43	12.29	1.09	3.33	0.22	2.10	2.38	5.87
7	71.52	13.15	0.64	2.59	0.16	1.37	3.12	6.09
8	71.94	13.35	0.74	1.73	0.50	1.19	3.22	5.52
9	74.14	12.51	0.58	2.02	0.09	1.09	2.67	5.80
The Laitila area.								
10	64.96	14.26	1.25	6.02	0.54	2.45	2.80	5.23
11	68.79	14.44	1.61	3.01	0.49	1.33	2.95	6.85
12	70.42	13.22	0.64	3.74	0.07	2.27	2.81	5.21
13	74.20	12.48	0.77	1.63	0.15	1.08	2.32	6.01
14	74.66	12.40	0.65	1.63	0.07	0.96	2.71	5.98
15	74.73	12.10	0.19	2.19	0.09	0.96	2.01	6.85
The Viipuri area.								
16	64.23	14 99	3.60	3.82	0.36	3.55	2.79	4.47
17	65.52	15.16	1.64	4.58	0.64	2.81	2.75	5.31
18	67.07	13.03	0.93	6.31	0.59	2.53	3.91	3.65
19	67.33	13.45	1.14	5.51	0.30	2.92	2.95	4.36
20	67.40	13.49	1.31	4.84	0.63	2.70	3.02	5.02
21	67.79	13.42	0.93	4.74	0.28	2.69	3.32	5.18
22	69.44	14.01	0.80	3.39	0.26	2.04	2.69	6.36
23	69.90	13.56	1.35	3.30	0.12	2.15	2.89	5.32
24	70.24	14.28	0.63	2.88	0.22	2.09	3.16	5.50
25	70.67	13.65	0.65	3.23	0.50	1.92	2.76	4.82
26	73.44	12.92	0.81	1.80	0.35	1.42	2.73	5.40
27	74.64	12.45	0.76	1.48	0.26	1.05	2.61	5.82
28	74.73	12.55	0.66	1.54	0.26	0.97	2.96	5.19
29	75.06	11.70	1.04	1.57	0.19	1.01	2.56	6.25
30	75.81	11.22	0.86	1.91	0.34	1.25	2.27	5.49
31	77.71	10.13	1.41	2.15	0.21	1.13	1.85	4.50
The Salmi area.								
32	75.26	12.71	0.97	1.11	0.29	0.66	2.65	5.56
33	75.50	12.15	0.96	0.96	0.37	0.86	2.73	5.22

saaret islands, presented by Wahl (1938), have not been considered. This circumstance is due to the fact that the above summary is compiled for the valuation of the average composition of the rapakivis of East Fennoscandia. As observed by many investigators in different connections, just the acid types are considerably more prevalent in the East Fennoscandian rapakivi areas than in the Swedish ones. The less acid rock types belonging to the rapakivi series met with to some extent here and there in the East Fennoscandian rapakivi areas, are obviously so small quantitatively that I have considered it best to omit them entirely from my average calculation.

Fennoscandian rapakivi granites.

H_2O+	H_2O-	MnO	TiO_2	ZrO_2	P_2O_5	BaO	F	Sum
0.60		0.14	0.44	—	0.13	—	—	100.45
0.37	0.09	0.04	0.19	—	0.09	—	—	99.86
0.60	0.05	0.04	0.62	—	0.04	—	0.28	99.99
0.83	0.25	0.04	0.65	0.08	0.34	0.13	0.27	100.37
0.76	0.24	0.08	0.65	0.09	0.24	0.11	0.20	100.50
0.53	0.13	0.06	0.83	—	0.08	—	0.09	100.39
0.56	0.15	0.04	0.19	0.07	0.02	0.05	0.23	100.13
0.72	0.25	0.04	0.46	0.05	0.31	0.03	0.11	100.11
0.62	0.07	0.03	0.28	0.06	0.24	0.03	0.18	100.33
1.20	0.13	0.10	0.85	—	0.05	—	—	99.84
0.50		tr.	0.38	—	tr.	—	—	100.35
0.63	0.09	0.04	0.52	0.11	0.09	0.13	0.46	100.26
0.65	0.22	0.02	0.36	—	0.02	—	—	99.91
0.26	0.04	0.02	0.28	—	0.02	—	0.32	99.55
0.50	0.03	0.01	0.36	—	0.06	—	0.22	100.21
0.49	0.12	0.10	1.32	—	0.43	—	—	100.27
0.39	0.28	0.08	1.00	—	0.40	—	0.11	100.67
0.16	0.20	0.17	1.15	—	0.36	—	0.08	100.14
0.53	0.05	0.07	0.94	—	0.07	—	0.34	99.96
0.53	0.06	0.09	0.96	—	tr.	0.09	0.31	100.45
0.47	0.08	0.08	0.90	0.01	0.05	0.09	0.32	100.35
0.44	0.20	0.11	0.33	—	0.19	—	0.05	100.31
0.54	0.07	0.06	0.67	—	tr.	0.11	0.20	100.24
0.41		0.04	0.35	—	—	—	—	99.95
0.49	0.09	0.04	0.88	—	0.23	—	—	99.93
0.45	0.07	0.02	0.40	0.05	0.06	0.17	0.34	100.43
0.37	0.06	0.03	0.33	0.04	0.10	0.05	0.47	100.52
0.62	0.05	0.02	0.24	0.06	0.04	0.04	0.41	100.34
0.63		—	0.36	—	—	—	—	100.37
0.40		tr.	0.32	—	tr.	—	—	99.87
0.46		tr.	0.48	—	—	—	—	100.03
0.89		0.02	0.25	—	0.04	—	—	100.41
0.52	0.08	0.01	0.50	—	0.06	—	—	99.92

Table V. Niggli values of the analyses in Table IV.

No.	*si*	*al*	*fm*	*c*	*alk*	*k*	*mg*	*c/fm*
1	339	34.5	26	9.5	30	0.50	0.18	0.37
2	562	44	12	3	41	0.56	0.20	0.25
3	449	43	13	6	38	0.61	0.03	0.46
4	310	34.5	26.5	12	27	0.53	0.07	0.46
5	365	36.5	21	9	33.5	0.49	0.04	0.43
6	365	37	20.5	11.5	31	0.62	0.08	0.56
7	375	40.5	15.5	7.8	36.2	0.56	0.08	0.51
8	388	42.5	15	7	35.5	0.53	0.27	0.46
9	430	43	13.5	6.5	37	0.59	0.06	0.51
10	271.0	35.1	28.6	11	25.3	0.55	0.12	0.38
11	319	39.5	20.5	6.5	33.5	0.60	0.16	0.31
12	352	39	19	12	30	0.56	0.03	0.65
13	441.4	43.8	13.0	6.8	36.3	0.63	0.10	0.53
14	445	43.5	12	6	38.5	0.59	0.05	0.52
15	449	43	13	6	38	0.69	0.06	0.49
16	261	36	26.5	15.5	22	0.51	0.09	0.58
17	271	37	25.5	12.5	25	0.56	0.16	0.50
18	282	32.5	30	11.5	26	0.38	0.13	0.38
19	296	35	26	14	25	0.50	0.07	0.54
20	292	34.5	26	12.5	27	0.52	0.16	0.48
21	300	35	23	13	29	0.51	0.08	0.57
22	328	39	19	10.5	31.5	0.60	0.09	0.55
23	340	39	19.5	11	30.5	0.55	0.05	0.60
24	343	41	16	11	32	0.53	0.10	0.69
25	355	40.5	20	10.5	29	0.54	0.18	0.52
26	411	42.5	15	8.5	34	0.56	0.20	0.57
27	441	43.5	13	6.5	37	0.60	0.17	0.50
28	448	44.5	12.5	6	37	0.53	0.17	0.48
29	447	41	14	6.5	38.5	0.62	0.12	0.45
30	460	40	17	8	35	0.61	0.18	0.49
31	509	39	21	8	32	0.62	0.10	0.38
32	453	45	13	5	37	0.58	0.20	0.34
33	468	44	13	6	37	0.56	0.26	0.44

1. Rapakivi granite. Haraldsby, Saltvik, Ahvenanmaa. Anal. Naima Sahlbom. Hackman (1905).
2. Quartz-porphyry belonging to the Ahvenanmaa rapakivi. Blåklobben, Eckerö. Anal. Lauri Lokka. Sederholm (1934).
3. Graphic granite. Boulder from Kivistö, Luvia. Derived from the bottom of the Gulf of Bothnia. Anal. E. A. O. Nordenswan (fluorine by Lauri Lokka). Eskola (1928).
4. Rapakivi. 100 m from the contact, Tjusgrund Island, Kustavi. Anal. Lauri Lokka. Kanerva (1928).
5. Rapakivi. Katanniemi. Anal. Lauri Lokka. Kanerva (1928).
6. Rapakivi. Kupusjärvi, Vehmaa. Anal. E. A. O. Nordenswan. Kanerva (1928).
7. Taivassalo granite. 1 km S. of the village Helsinki. Anal. Lauri Lokka. Kanerva (1928).
8. Dotted porphyritic granite of Riittiö, aplitic. Ab. 500 m S.E. of the farm Kuuskorpi in Mietoinen. Anal. Lauri Lokka. Kanerva (1928).
9. Vehmaa granite. Quarry at Uhlu. Anal. Lauri Lokka. Kanerva (1928).
10. Tarkki granite. Tarkki, Eurajoki. Anal. E. A. O. Nordenswan. Laitakari (1928).
11. Rapakivi granite. Eurajoki Station. Anal. Naima Sahlbom. Hackman (1905).
12. Rapakivi. Pyhäranta, Laitila. Anal. Lauri Lokka. Eskola (1930).

13. Väkkärä granite. Väkkärä, Eurajoki. Anal. E. A. O. Nordenswan. Laitakari (1928).
14. Rapakivi aplite. Liesjärvi, Hinnerjoki. Anal. E. A. O. Nordenswan. Eskola (1928).
15. Dotted granite. Kodisjoki, Laitila. Anal. E. A. O. Nordenswan. Eskola (1928).
16. Rapakivitic quartz monzonite porphyry, light grey. Taalikkala—Haapajärvi. Anal. Lauri Lokka. Hackman (1934).
17. »Tirilite». Quarry Kolehmainen, S.E. of Lappeenranta. Anal. Naima Sahlbom. Hackman (1934).
18. Lappee granite. Quarry Runeberg, S. of Lappeenranta. Anal. Lauri Lokka. Hackman (1934).
19. Lappee granite. Quarry in Kiviharju, Lappeenranta. Anal. Lauri Lokka. Hackman (1934).
20. Green rapakivi. Quarry at Simola, Lappee. Anal. Lauri Lokka. Hackman (1934).
21. Lappee granite. Great quarry at Hytti, Lappee. Anal. Lauri Lokka. Hackman (1934).
22. Green rapakivi. W. of the railway station Kaitjärvi. Anal. Naima Sahlbom. Hackman (1934).
23. Green rapakivi. Quarry S. of Suurkuukka, Tani, Lappee. Anal. Lauri Lokka. Hackman (1934).
24. Rapakivi (wiborgite). Muhulahti, Säkkijärvi. Anal. R. Mauzelius. Wahl (1925).
25. Sinkko granite, light grey, porphyritic. Karkkola, Lappee. Anal. Lauri Lokka. Hackman (1934).
26. Coarse-grained rapakivi. Quarry S. of Suurkuukka, Tani, Lappee. Anal. Lauri Lokka. Hackman (1934).
27. Fine grained rapakivi granite. Quarry Pohjolan Kivi, Kanalampi, Lappee. Anal. Lauri Lokka. Hackman (1934).
28. Rapakivi granite porphyry. Tyysterniemi, Lappeenranta. Anal. Lauri Lokka. Hackman (1934).
29. Rapakivi granite (pyterlite). Hämeenkylä, Pyterlahti. Anal. Struve. Hackman (1905).
30. Rapakivi granite (pyterlite). Pyterlahti. Anal. Naima Sahlbom. Hackman (1905).
31. Rapakivi granite (pyterlite). Pyterlahti. Anal. Struve. Hackman (1905).
32. Rapakivi granite. Pitkäranta. Anal. I. G. Sundell. Hackman (1905).
33. Rapakivi. Tshasonkallio, Salmi. Anal. Lauri Lokka. Lokka (1934).

The average calculated from the analyses tabulated above (Tables IV, I, and XI) is presented in Table VI. Additionally, the numbers of the respective determinations as well as the limits of deviations observed are given therein. For the sake of comparison the general average of all granites calculated by Daly (1933) and the rapakivi average of Sederholm are included in the Table.

For all average compositions of rapakivi granites calculated by different authors, and for pyterlitic and wiborgitic rapakivi magma as defined by Wahl, the Niggli values are collected together in Table VII below.

In order to get a general view of the variations in the chemical composition of the acid members of the rapakivi series in East Fennoscandia, the Niggli values *al*, *fm*, *c*, and *alk* of Table V (and in addition II and XII) are plotted against the respective values of *si* in Fig. 6. Besides, the respect-

Table VI. Average composition of all granites according to R. A. Daly and rapakivi granites according to J. J. Sederholm and according to the recent analytical data of the rapakivi granites of East Fennoscandia.

	Granite average (Daly)	Rapakivi average (Sederholm)	Average of the analyses of the East Fennoscandian rapakivi granites available		
			%	Number of determinations	Limits of deviations observed
SiO_2	70.18	72.57	71.79	37	64.23—77.71
Al_2O_3	14.47	12.62	12.95	37	10.13—15.72
Fe_2O_3	1.57	1.45	0.99	37	0.10— 3.60
FeO	1.78	2.41	2.77	37	0.50— 6.31
MgO	0.88	0.46	0.28	37	0.04— 0.65
CaO	1.99	1.34	1.59	37	0.10— 3.55
Na_2O	3.48	2.30	2.83	37	1.85— 3.91
K_2O	4.11	6.10	5.48	37	3.65— 6.85
H_2O+	} 0.84	} 0.49	0.54	30	0.16— 1.20
H_2O-			0.12	30	0.03— 0.28
MnO	0.12	0.02	0.05	36	tr. — 0.17
TiO_2	0.39	0.25	0.52	37	0.16— 1.32
ZrO_2	—	—	0.06	10	0.01— 0.11
P_2O_5	0.19	0.02	0.13	34	tr. — 0.43
BaO	—	—	0.08	16	0.03— 0.17
F	—	—	0.23	24	0.04— 0.47
	100.00	100.03	100.41		

Table VII. Average Niggli values for rapakivi granites.

	Pyterlitic rapakivi (Wahl)	Wiborgitic rapakivi (Wahl)	Rapakivitic magma type (Niggli)	Rapakivi average according to		
				Sederholm	Recent analyses	The standard mixture in Table VIII
si	470	340	380	388	375	408
al	40	40	40	40	40	43
fm	17	17	18	20	18	15
c	7	11	9	8	9	6
alk	35	32	33	32	33	36
k	0.62	0.54	0.50	0.64	0.56	0.54
mg	0.15	0.15	0.27	0.17	0.12	0.10
c/fm	0.48	0.68	0.50	0.40	0.50	0.40

ive Niggli values of the average compositions of Table VII are included in the figure. For the general granite average of Daly the Niggli values are as follows: *si* 328, *al* 40, *fm* 19, *c* 10, *alk* 31, *k* 0.40, *mg* 0.32, and *c/fm* 0.53.

As shown by Fig. 6 the chemical composition of the acid members of the rapakivi series changes regularly so that in increasing of *si* the values of *c* and *fm* decrease and *al* as well as *alk* increase. Considering that in the diagram there are representatives of all the different rapakivi areas of East Fennoscandia, and that the diagram thus portrays a fairly extensive granite group, exceptions from the average changes in question must be considered as being relatively small. This shows that the rapakivis in question really represent a very consistent rock series with a well defined chemical composition.

However, on examining the diagram it is conspicuous that one analysis with a *si* value of 509 deviates considerably from the general rule.

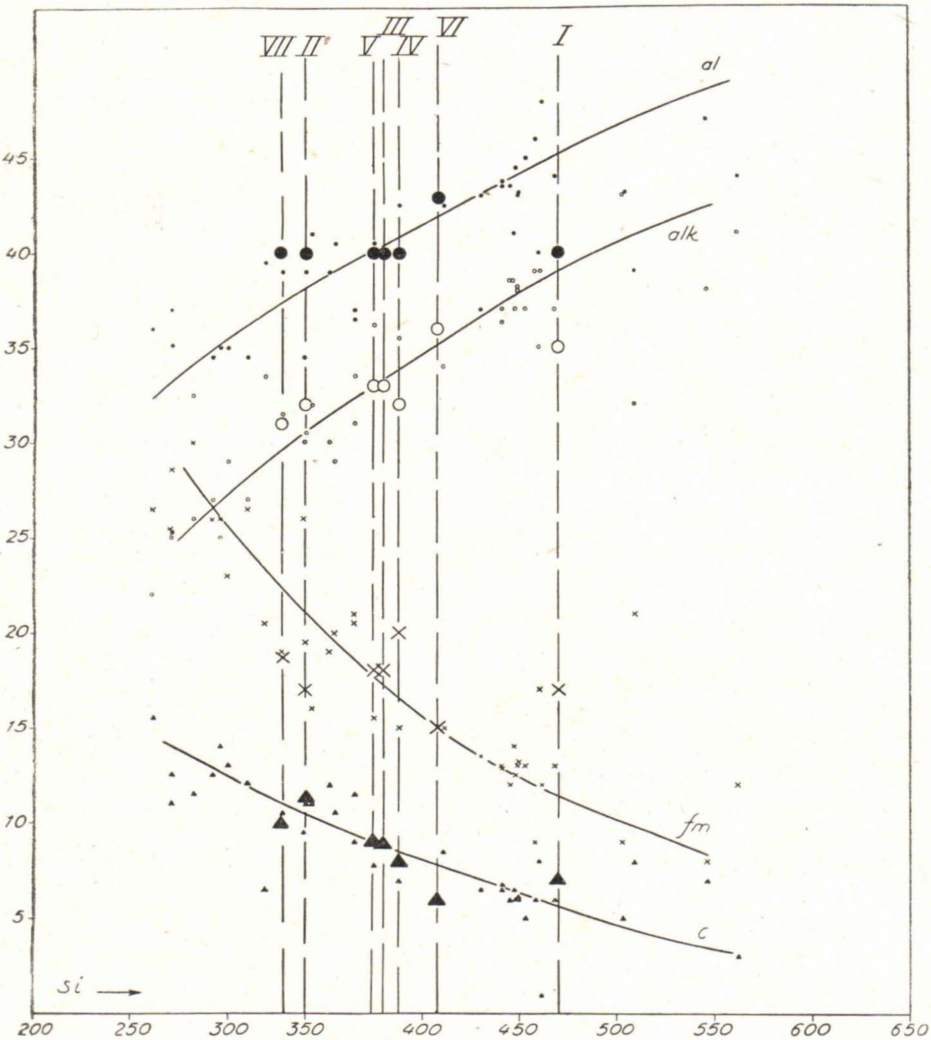

Fig. 6. Differentiation diagram of the acid members of the East Fennoscandian rapakivi granites based on the Niggli values of Tables V, II and XII. In addition the following mean calculations (Table VII): I pyterlitic rapakivi (Wahl). II wiborgitic rapakivi (Wahl). III rapakivitic magma type (Niggli). IV rapakivi average according to Sederholm. V rapakivi average according to the recent analytical data. VI standard mixture of the East Fennoscandian rapakivi granites. VII All granites (Daly).

Its *c*-value is already situated considerably on the side of the average *c*-curve, but particularly the *fm*, *al*, as well as *alk* values are located rather far from the respective curves. This analysis is No. 31 in Table IV and represents an old analysis by Struve of the rapakivi of Pyterlahti. Thus it is exceedingly likely that the analysis in question is inaccurate and unreliable, and as such it ought to have been excluded from the average calculations. Because, however, as already pointed out by Wahl, the analysis in question seems to be comparatively serviceable, I have considered it in this connection. We have no right to demand from each individual analysis a complete suitability to the general differentiation diagram of the rapakivis, as we should then, already when choosing the analysis, make ourselves liable to a certain advance choice which would naturally decrease the usable value of the calculated average figure. When making average calculations an omission of only such analyses is justified in which the respective analysis seems already outwardly unreliable, such as, for instance, the analyses of Lemberg because of their suspicious alkali ratio.

On the other hand, another fact deserves notice in this connection. As previously mentioned, Wahl, when calculating the average figure of the pyterlitic rapakivi composition, had at his disposal only three analyses of the Viipuri area and one of the Pitkäranta rapakivi. Analysis No. 31 was one of them. It is thus quite to be expected that even one unreliable analysis could essentially affect the individual figure values of his average composition. In Fig. 6 the Niggli values of Wahl's pyterlite composition are plotted and, as the diagram shows, they really match relatively badly — of all presented average compositions the absolutely worst — with the individual points of the diagram. Because of this it seems that the pyterlite composition prensented by Wahl is somewhat inaccurate; it deviates from the course of the general differentiation of rapakivis.

As regards the whole pyterlite and wiborgite conceptions presented by Wahl, Fig. 6 shows that the average compositions for the respective rapakivi types fixed by him are by no means characteristic of those types only, but that rocks of the same composition are met with even among rapakivis texturally not at all representing the named types. Further, the type compositions mentioned by no means represent any specially abundant rapakivi compositions, but only some members of a continuous series. For this reason it seems better to limit both the type terms to refer to the respective rapakivi textures only, without giving them any additional chemical meaning. It is true that Sederholm (1928) with good reason even in general opposes the use of these terms also as textural ones, but if, when considering the classical reputation attained by them, one wishes to use them at all it seems to be more suitable, in view of the analysis material nowadays available, to use both terms in a textural sense only.

Finally, when examining the average calculations III—VI presented in Fig. 6, it can be observed that they are comparatively well suited to represent the average composition of the acid members of the rapakivi granites. Maybe the most inaccurate of them is Sederholm's average calculation. The average composition of granites, presented by Daly (No. VII in the figure), lies relatively close to Wahl's wiborgitic composition and it deviates considerably from the average composition of all rapakivi granites. As already to be seen from Table VI, rapakivis contain on an average somewhat less Al_2O_3, MgO and CaO than granites on an average, the alkali ratio, in addition, being clearly changed in favour of potassium.

STANDARD MIXTURE OF RAPAKIVI GRANITES.

MAKING THE MIXTURE.

The summary given above of the chemistry of the acid members of the rapakivi series and of their average composition clearly shows — for the main elements as well as for some trace elements — the special features characteristic of the rocks in question. An exceedingly widely spread rock group like the rapakivi granites of East Fennoscandia being in question, the chemical composition varies notably in different districts and types. The disturbing effect of these local and areal variations is obvious when clearing up the general chemistry of the acid members of the rapakivi series. As already mentioned in the introduction, my intention is to try to present a survey of that special chemical character, considered with good reason as being typical of the rocks in question, especially in regard to trace elements.

In order to attain the aim presented, I have proceeded in such manner that I have chosen a number of samples from all the rapakivi areas in question and have prepared from them an average mixture, which has been analysed as thoroughly as possible. Against this manner of proceeding it can now be rightfully remarked, that a much more reliable picture of the matter could be obtained by analysing each of the chosen samples separately and — if desired — by calculating the average of the results. This is undoubtedly true, but the amount of work demanded by such an investigation would then be exceedingly great and would be practically impossible, especially under present conditions, or at least be very difficult to realize. On the other hand, it is, however, to be borne in mind that the mode of procedure followed by me may be justified in cases where, according to the presentation of the problem in the introduction, a general investigation of the chemistry of the acid rapakivi granites is in question, without any wish of looking into areal details. As a matter of fact, when characterizing geochemically some geological or petrographical formation like the East Fennoscandian rapakivi granites, one must always finally fall back upon averages. However, it should not be forgotten that the method used, general in geological and petrographical investigations, has its own limitations always worth considering when judging the results.

Unfortunately, when preparing the average mixture, I did not have any possibilities of obtaining for my use (with the exception of the rapakivi samples presented in Tables I and XI) any original material from samples already earlier analysed and the corresponding analyses of which have been presented in literature. However, it is questionable whether this circumstance can in general be at all considered as a defect. One could just as well say that at least in its major part the average mixture of new and not earlier analysed samples is in fact primarily more favourable, because its reliability for the purpose can be controlled in regard to the main elements, as well as in regard to several trace elements, by comparing its composition with the average rapakivi analyses obtainable from literature.

A list of the samples used in the average mixture is presented in the list given below, wherein there is also mentioned the quantity of each sample used for the mixture. The mixture itself was carefully homogenized by mixing for two hours in a suitable vessel.

STANDARD MIXTURE OF THE EAST FENNOSCANDIAN RAPAKIVI GRANITES.

The Ahvenanmaa area. (1 g of each)

No. 1. Ahvenanmaa.
2. Maarianhamina (Mariehamn).
3. Kumlinge.
4. Borgskär, Kumlinge.
5. Enklinge, Kumlinge.
6. Pepparn, Hammarland.
7. Hammarland.
8. Druvan, Jomala.
9. Svinö, Jomala.
10. Herrö, Lemland.
11. Stora Lakskär, Lemland.
12. Pörkö, Lemland.
13. Inre Bredan, Brändö.
14. Inre Bredan, Brändö. (Aplitic type).
15. Långö, Vårdö.
16. Föglö.
17. Föglö. (Rapakivitic Granite).
18. Kökarsfjärden, Kökar.
19. Kökarsfjärden, Kökar.
20. Blåklobben, Eckerö.
21. Jeta.

The Vehmaa area. (1 g of each).

22. Kupusjärvi, Vehmaa.
23. Kustavi.

24. Stornskär, Kustavi.
25. Malö, Kustavi.
26. Kalanniemi, Lypertö, Kustavi. (Aplitic type).
27. Small island S.W. of Lypertö, Kustavi.

The Laitila area. (1 g of each).

28. Haukkavuori, Säkylä.
29. Raponkylä, Pyhämaa. (Porphyritic variety).
30. Suutila, Karjala.
31. Liesjärvi, Hinnerjoki. (Aplitic vein in rapakivi).
32. Naarjoki, Eura.
33. Kalliinnokka, Pyhäranta, Yläne.
34. Myllyranta, Huvitus, Yläne.
35. Korvenkylä, Luvia.
36. Korvenkylä, Luvia.

The Viipuri area. (3 g of each).

37. Tyysterniemi, Lappeenranta.
38. Quarry Kolehmainen, Lappeenranta. (Tirilite).
39. Ihalainen, Lappeenranta.
40. Tirilä, Lappe. (Tirilite.)
41. Quarry Suurkuukka, Tani, Lappee. (Contact between pyterlite and green rapakivi).
42. Quarry Suurkuukka, Tani, Lappee. (Contact between pyterlite and green rapakivi).
43. Antamoinen, Taalikkala, Nuijamaa. (Porphyritic type).
44. Pyterlahti.

The Salmi area. (2 g of each).

45. Kivenkula, Pitkäranta.
46. Pitkäranta. (Porphyritic type).
47. Koirinoja, Impilahti.
48. Tshasonkallio, Salmi.
49. Uuksu, Salmi.
50. E.-shore of the lake Tulemajärvi.
51. Koirinoja. (Table I on p. 26) Impilahti.
52. Pensanoja. (Table I on p. 26).
53. Uomaa, Salmi (Boulder). (Table I on p. 26).
54. Ihovaara, Suistamo. (Table XI on p. 59)

ANALYSIS METHODS.

The standard mixture of the rapakivi granites of Eastern Fennoscandia mentioned above was first analysed chemically in the usual manner by Mr. Ahti Simonen, M. A., of the Geological Survey. The following components were determined: SiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, Na_2O, K_2O, H_2O +, H_2O —, TiO_2, MnO, P_2O_5, ZrO_2, BaO, F, Cl, S (total sulphur), CO_2. After subtraction of the oxygen for F, Cl and S the sum of the determined components lies at 100.13. In this connection it is especially to be mentioned that the chemical barium and zirconium determinations gave as result respectively 0.10 % BaO and 0.12 % ZrO_2.

P h e n y l a r s o n a t e p r e c i p i t a t e. For the determination of zirconium, hafnium, niobium and tantalum from the average mixture a chemical pre-enrichment was performed. According to the instructions given by Rankama (1944) ab. 11.6 gram of the mixture was brought into solution and precipitated with phenylarsonic acid. The ignited precipitate amounted to 0.39 % of the bulk.

A small amount of this precipitate was taken for determination of zirconium and hafnium. A known amount of X-ray spectrographically pure Y_2O_3 and Er_2O_3, weighed out by a micro balance, was added to the sample and the mixture thoroughly homogenized. The X-ray spectra were photographed and the films measured photometrically in the usual manner.

The z i r c o n i u m content was calculated from the intensity rations $ZrK\alpha_1/YK\alpha_1$ and $ZrK\alpha_2/YK\alpha_2$ as described by Minami (1935). Using $K\alpha_1$-lines the result was 0.13 % ZrO_2 and with $K\alpha_2$-lines 0.11 % ZrO_2, or, as an average from both determinations, 0.12 % ZrO_2 in the original sample. This value happens to be exactly the same as that found chemically by Simonen.

The determination of h a f n i u m was made by comparing the line $HfL\alpha_1$ with the erbium lines $L\beta_1$ and $L\beta_2$. The calibration in question was effected according to the principles given by Sahama, Rankama and Heinäsuo (1941) for the X-ray spectrographical determination of tantalum. The result was 0.0028 % HfO_2.

For n i o b i u m two different methods of determination were used. The phenyl arsonate precipitate mentioned above was photographed optically without any comparison substance with a glass spectrograph. In corresponding standard spectra containing known amounts of Nb_2O_5 in quartz and sodium carbonate the line Nb 4058.97 mentioned by v. Tongeren (1938), free from disturbing coincidences, could be easily seen on a concentration step of 0.001 % Nb_2O_5. An amount a little less than this can obviously be visible too. A visual comparison of the spectrum of the pre-enrichment product with the standard spectra gave as a result ab. 0.2 % Nb_2O_5 in the precipitate, corresponding to ab. 0.0008 % Nb_2O_5 in the original sample. Additionally, another determination in a similar manner was effected straight from the original rapakivi mixture without any chemical pre-treatment. The result was 0.001 % Nb_2O_5. This last mentioned value is given in Table VIII.

The whole amount of the pre-enrichment product mentioned above having been used for the determinations of Zr, Hf and Nb, a new enrichment was made for t a n t a l u m. In accordance with Rankama's instructions *(l. c.)* the phenyl arsonate precipitate was boiled with salicylic acid in order to bring the titanium content of the precipitate into solution. The final product, containing mainly zirconium (and hafnium), amounted to 0.13 % of the bulk. This product was photographed with X-ray spectrograph and the spectrum compared visually with standard spectra as made by Rankama. Just at the limit of vision the tantalum line corresponded to about 0.1 % Ta_2O_5 in the precipitate or ab. 0.0001 % Ta_2O_5 in the bulk.

R a r e e a r t h p o r t i o n. The rare earths were enriched chemically for a quantitative determination by the aid of X-ray spectrography. The enrichment was effected mainly according to the method given by Minami (1935). The comparison substances used and the calculation of the photometer curve are also given by him. The special details of the method coming into question for the apparatus used by the author have been given previously by Sahama and Vähätalo (1939).

All the following determinations were made by the aid of optical spectrography.

B a r i u m and s t r o n t i u m were determined photometrically straight from the original sample, lanthanum being used as a comparison element, as briefly mentioned by the author (1945). It is to be noted that a number of parallel determinations gave 0.10 % BaO as an average for barium. This value is exactly the same as found chemically by Simonen.

Rubidium too was determined photometrically according to the method previously given in detail by Erämetsä, Sahama and Kanula (1941). The result, 0.16 % Rb_2O of the bulk, was subtracted from the value of K_2O found chemically by Simonen.

The lack of caesium was established in the infra red spectral region in which the sensitivity lies at ab. 0.001 % Cs_2O.

Boron was determined mainly in a like manner as described by Landergren (1945), using antimony as a comparison substance.

For an optical determination of germanium a chemical pre-treatment was necessary. The observation of Rankama (1939) was used, according to which germanium shows a highly marked tendency to remain enriched in the residue of silica in the course of a rock analysis. The enrichment was effected as follows: About 3 gram of the sample was fused with sodium carbonate and the cake taken up in nitric acid. Hydrochloric acid cannot be used because the germanium chloride will be partly volatilized already in the temperature of the water bath. The solution was evaporated to dryness a couple of times and the insoluble silica filtered off as usual. The precipitate was treated with hydrofluoric and sulphuric acids and the residue photographed with a quartz spectrograph. The amount of the residue from silica was 1.15 % of the bulk and contained according to a visual comparison with standard spectra 0.003—0.01 % GeO_2. The intensity of the germanium line lies nearer to the upper limit corresponding to ab. 0.008 % GeO_2 in the enrichment product or 0.0001 % GeO_2 in the original sample.

The determination of lithium was made mainly according to the principles given by Strock (1936), using strontium as a comparison element.

The following components were determined only visually through a comparison with standard spectra:

PbO	sensitivity	0.001 %
Ga_2O_3		0.001
BeO		0.0003
NiO		0.0003
CoO		0.001
Cr_2O_3		0.0001
V_2O_5		0.0001
Sc_2O_3		0.0001

As for the lines used *cf.* Rankama (1939).

COMPOSITION OF THE MIXTURE.

To sum up all the determinations mentioned above, the following composition may be presented for the standard mixture of the East Fennoscandian rapakivi granites (Table VIII). In Table IX the molecular proportions for the main components are given. The Niggli values of the standard mixture are given already in Table VII.

Concerning the trace elements the following statements may be presented.

The content of titanium is practically almost identical with that found by Daly for the average of all granites. The same is the case as regards also phosphorus and manganese.

Table VIII. Chemical composition of the standard mixture of the East Fennoscandian rapakivi granites.

SiO_2	72.58	ZrO_2	0.12	ThO_2	0.004
Al_2O_3	12.98	HfO_2	0.0028	Sc_2O_3	0.0001
Fe_2O_3	0.86	Nb_2O_5	0.001	BaO	0.10
FeO	1.83	Ta_2O_5	0.0001	SrO	0.012
MgO	0.25	La_2O_3	0.0040	Rb_2O	0.16
CaO	1.01	Ce_2O_3	0.0080	Cs_2O	0
Na_2O	3.01	Pr_2O_3	0.0017	Li_2O	0.0050
K_2O	5.28	Nd_2O_3	0.0060	GeO_2	0.0001
H_2O+	0.66	Sm_2O_3	0.0013	Ga_2O_3	0.01
H_2O-	0.38	Gd_2O_3	0.0018	BeO	0.001
TiO_2	0.34	Tb_2O_3	0.0004	B_2O_3	0.002
MnO	0.11	Dy_2O_3	0.0008	PbO	0.006
P_2O_5	0.18	Ho_2O_3	0.0002	NiO	0.0003
F	0.36	Er_2O_3	0.0006	CoO	0
Cl	0.06	Yb_2O_3	0.0004	Cr_2O_3	0.005
S (total)	0.05	Lu_2O_3	0.0001	V_2O_5	0.0003
CO_2	0.05	Y_2O_3	0.0051		

Table IX. Molecular proportions of the analysis of Table VIII.

SiO_2	1 204
Al_2O_3	127
Fe_2O_3	5
FeO	26
MgO	6
CaO	18
Na_2O	49
K_2O	56
H_2O+	37
TiO_2	4
MnO	2
P_2O_5	1
F	19
Cl	2
ZrO_2	1
Rb_2O	1

The two halogenes, fluorine and chlorine, are very important as regards the present purpose. In general our knowledge about the abundance of these elements in various rock groups of igneous, sedimentary or metamorphous origin is very scarce. According to the calculations of Clarke and Washington (1924) the igneous rocks contain on an average 0.048 % Cl and 0.03 % F. Chlorine is thus in weight in excess over fluorine. Those rock analyses in which both chlorine and fluorine are given quantitatively are not very numerous and I believe that it is not possible at present to set up any dependable average figures for the content of these elements in granites. From the mode of occurrence of fluorine it is known that it enters to a considerable amount in place of the hydroxyl ion in the lattice of the »water-containing» minerals. Due to the greater ionic radius this is, however, not possible for chlorine. Of the most important carriers of chlorine in rocks only apatite is known. As shown by

Kind (1939), chlorine is always in excess over fluorine in the true magmatic apatites, but the chlorine-fluorine ratio is clearly changed in favour of the latter in apatites of more acid rock groups.

As regards the East Fennoscandian rapakivi granites there is in literature not a single chlorine determination available. The respective figure presented in Table VIII can thus not be compared with any previous data. On the other hand, the determinations of fluorine in rapakivi granites in East Fennoscandia are relatively numerous, as is perceived already from Table IV. Fluorine is, indeed, undisputably one of the most characteristic trace elements of the rock series in question. As seen from Table VI, the figure for the average fluorine content on the basis of the determinations tabulated in Table IV is as high as 0.23 % F. The determination of Simonen from the present standard mixture gave as its result the still higher value of 0.36 % F. One must, of course, reckon with the possibility that the samples taken for the average mixture have been a little richer in fluorine than the respective rocks in general, but even if this should have been the case, the content of fluorine would anyhow without doubt, be exceptionally high just in the rapakivi granites. It is possible that the chlorine content, too, is slightly higher than in granites on the average, but the fluorine is at any rate much more abundant in rapakivi granites than in other granitic rocks. Thus the abundance ratio of chlorine and fluorine is very characteristic of the rapakivi granites of East Fennoscandia. This circumstance is clearly illustrated by the common occurrence of fluorite as an accessory mineral in these rocks. In some varieties topaz, too, plays a certain role. Taking the fact into account that according to Tschirwinsky (1928) a granite biotite contains on an average 0.18 % F, it is obvious that biotite is also to be regarded as one of the fluorine carriers of the rapakivi granites. This being the case, the East Fennoscandian rapakivi granites can be said to contain on an average at least ab. one half percent fluorite.

Seeing from Table IV that relatively numerous determinations of z i r c o n i u m from the East Fennoscandian rapakivi granites are available, a comparison with these previous data can be made. Like fluorine, also zirconium is to be regarded as one of the most characteristic trace elements of the rapakivi granites. As an average of the earlier determinations a zirconium content of 0.06 % ZrO_2 can be set up for the present rocks. However, the figure given in Table VIII, *viz*, 0.12 % ZrO_2, differs remarkably from this value. As mentioned above in connection with the analysis methods used, the chemical determination of Simonen and the X-ray spectrographical determination of the author gave results which were in excellent harmony with each other. The figure presented for the rapakivi standard mixture can thus be regarded as really representing the true zirconium content in this mixture. As in the case of fluorine, the possibility that the zirconium content found in the standard rapakivi mixture would be a little higher than in the rapakivis in general is certainly to be reckoned with, but the very abundant occurrence of the mineral zircon in all rocks of the rapakivi series makes it evident that these rocks really are exceptionally rich in this element. According to v. Hevesy and Würstlin (1934) granitic rocks contain on an average ab. 0.03 % Zr, corresponding to ab. 0.04 % ZrO_2. The only granitic rock groups in the Finnish Pre-Cambrian from which an average zirconium content is known are the granitic and gneissose granitic rocks of Southern Finnish Lapland. As found by the author (1945), the rock groups in question contain some few hundredths of a percent of ZrO_2. These spectrographical determinations being only visual estimations with standard spectra, a direct comparison with the corresponding figure of the present rapakivi granites is indeed perhaps a little venturesome, but the difference in absolute intensity of the zirconium line for, say, 0.03 % and 0.1 % ZrO_2, seems to be strong enough to allow these two concentration steps to be discerned. When comparing visually the spectra of the granitic rocks of Lapland mentioned above with those of the present rapakivi granites, the zirconium lines in the spectra of the last named rocks are clearly stronger.

Assuming that the zirconium amount present is wholly bound to the mineral zircon, the content of this mineral in the rapakivi granites of East Fennoscandia would be ab. 0.18 % on an average.

In addition, the abundance of h a f n i u m and especially the zirconium-hafnium ratio may be considered. The figure for zirconium as well as that for hafnium representing relatively accurate values instead of being results of a visual estimation of some spectral lines only, the concentration ratio of both these elements can be given exactly. The relation of the respective oxides in weight is ZrO_2: HfO_2 = 100 : 2.3. As found by v. Hevesy (1925), the concentration relation of both these elements shows in general but relatively minute variations in different zirconium minerals, excepting in a few special cases. The respective variations in the bulk of rocks and rock classes are at present very little known, but there is no reason to expect any great variations in them either. As a matter of fact, the only tendency known so far is a slight impoverishment of hafnium in relation to zirconium in nephelite syenites when compared with the calcialkalic granites. The relation stated above for rapakivi granites is in full harmony with the corresponding figures for granitic rocks expressed by v. Hevesy.

As to the content of the two earth acids n i o b i u m and t a n t a l u m, there are some previous data for comparison. For tantalum a fairly extensive analysis material from Finnish rocks has been given by Rankama (1941 and 1944). According to the determinations carried out by him, the rapakivi granites evidently are richer in tantalum than the oldest gneissose granites of the Sveco-Fennidic orogenic zone belonging to group I of Sederholm's classification. As for group II of the same zone (Hanko type), the calculated average figure is a little higher than in the rapakivis, but one has to reckon with the possibility that two of the granites analyzed by Rankama and found to be remarkably rich in tantalum, *viz.*, those of Kalliojärvi in Tammela and Kankaanpää, really are exceptions only. These two determinations have, however, a considerable effect upon the mean value of the respective granite group. When considering the separate analysis reported by him, it seems fairly possible that the tantalum content in the rapakivi series can in general be a little higher than in this granite group. On the other hand, it is obviously smaller than in the youngest Archaean granites of Sederholm's group III. — For niobium only the mean value of Goldschmidt (1937) for granites in general, *viz.*, 0.005 % Nb_2O_5, is known. This figure is certainly slightly higher than in the rapakivis on an average.

As will be perceived from the description of the analysis methods used (*cf.* p. 42), the niobium and tantalum content of the present mixture was not determined with the same accuracy as the content of zirconium and hafnium. The ratio $Nb_2O_5 : Ta_2O_5$ can thus not be as exactly expressed. Taking into consideration the errors of the method it seems, however, that the ratio in question does not lie very far from 10 : 1. This figure is practically the same as that previously set up by Rankama (1944) for the abundance relation of these two elements in the lithosphere on an average. It seems that in the rapakivi granites neither of the earth acids mentioned has been enriched to any considerable degree in relation to the other.

The rare earth portion in the rapakivi standard mixture, including the l a n t h a n i d e s, y t t r i u m, s c a n d i u m, and t h o r i u m, amounted to 0.03—0.04 % of the bulk. Qualitative observations of the occurrence of these elements in the Finnish granites have previously been made by Sahama and Rankama (1938). By the aid of X-ray spectrography a few quantitative determinations have later on been carried out by Sahama and Vähätalo (1939). Recently the author (1945) has given some additional data from the rocks of Southern Finnish Lapland.

In the present connection it is worth noting that the determinations given by the author and Vähätalo *(l. c.)* are made of rocks especially rich in the elements in question. Thus, the figures given therein are by no means to be regarded as representative of the respective rock groups. As shown by the author and Rankama *(l. c.)*, the rare earths in the Finnish granites are subject to considerable fluctuations. In addition to the previous qualitative and quantitative data mentioned above, it is to be stated that the older granites on an average contain less rare earths than the youngest granites of the Sveco-Fennidic area of South Finland as well as of the North Finnish continuation of the Karelidic zone. As to the rapakivi granites, the rare earth content is without doubt higher than in the older Pre-Cambrian granites on an average. How the matter stands in relation to the youngest Archaean granites (Sederholm's group III) does not seem to be quite clear. It appears fairly possible that the rapakivi granites show somewhat less rare earths than these granites on an average, but the difference is by no means great. At any rate, the rapakivi granites are to be regarded as relatively rich in the elements in question. This fact is very remarkable, as no lanthanide minerals proper have ever been observed in the rapakivi granites. Thus, because of the lack *e. g.*, of monazite and allanite, the rare earths are obviously bound to minerals like apatite and fluorite. As is perceived from Fig. 7, showing graphically the con-

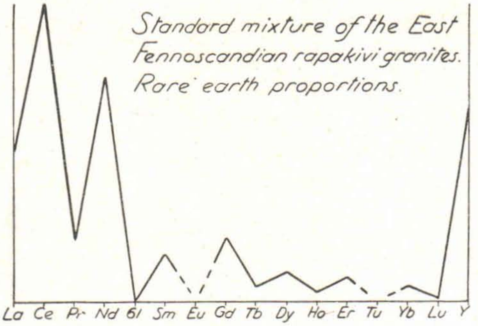

Fig. 7. Relative rare earth concentrations in the rapakivi standard mixture.

centration relations of the lanthanides and yttrium, the curve represents really a type very close to the apatite type put forward by Goldschmidt and Thomassen (1924). Additionally, it is to be borne in mind that the zircons and perhaps also biotites, as well as sometimes the potash feldspars are able to contain minute amounts of these elements (*cf.* for instance Haberlandt and Köhler 1940). Characteristic of the whole rapakivi series seems to be the fact that the rare earths do not form any one of their minerals proper, but enter into the lattices of other mineral species. In this respect they differ remarkably from the youngest Archaean granites in general.

In their abundance in the rapakivi granites the two earth alkali metals barium and strontium show some characteristic features. Their determinations being based on photometrical measurements, the respective figures are to be regarded as relatively accurate. In order to compare the concentration relations of barium, strontium, and potassium in the most important calci-alkalic igneous rock classes with the average of the rapakivi series the following Table X may be presented. In addition, the data obtained by the author (1945) from the youngest granites of Southern Finnish Lapland are included in the table. For the averages of the peridotite, gabbro, diorite, and granite classes the figures for potassium are taken from Daly (1933) and those for barium and strontium from v. Engelhardt (1936) and Noll (1934) respectively.

Table X. Abundance relation of potassium, barium, and strontium in some igneous rocks.

	K_2O %	BaO %	K_2O:BaO	SrO %	BaO:SrO
Peridotite	0.04	0.0003	100 : 0.75	—	—
Gabbro	0.89	0.007	100 : 0.79	0.02	100 : 286
Diorite	2.12	0.03	100 : 1.4	0.03	100 : 100
Granite	4.11	0.05	100 : 1.2	0.01	100 : 20
Youngest granites of Finnish Lapland	4.41	0.070	100 : 1.6	0.011	100 : 16
Rapakivi standard mixture	5.28	0.10	100 : 1.9	0.012	100 : 12

As will be perceived from the table, the relation K_2O:BaO shows but small variations in the more acid rock classes, *i. e.* in the diorites and granites. Due to its great ionic radius, barium obviously follows potassium in the magmatic differentiation to a certain degree and is enriched together with it in the acid rock groups. As is well known, a high content of potassium is one of the most characteristic features of the typical rapakivi composition. Like zirconium and fluorine, barium is one of the few trace elements of which a considerable number of quantitative determinations are available previously *(cf.* Table IV on p. 33). An average of these figures, *viz.*, 0.08 % BaO, differs but slightly from the respective value found for the present standard mixture, *viz.*, 0.10 % BaO. As mentioned above (p. 42), this figure was obtained chemically by Simonen and by the aid of optical spectrography by the author. Accordingly, there is good reason to regard it as representative in respect of the standard mixture. Thus, as previously could be expected, barium is remarkably enriched in the rapakivi series, and this enrichment is in good harmony with the known enrichment of potassium in the series. As seen from Table X, this enrichment is, in addition, slightly stronger in regard to potassium than in the granites on an average. The enrichment of barium in the rapakivi series is realized both relatively in regard to potassium and also in its absolute amount.

Besides to the potassium-barium ratio, attention is to be paid also to the barium-strontium ratio in the rapakivis. Expressing this ratio on the basis of BaO = 100, the matter is clearly seen in Table X. There the granitic rock groups differ strongly from the basic and intermediate rock classes. The impoverishment of strontium in relation to barium in all the mentioned granite groups is evident. Here also the special nature of the rapakivi composition is to be seen, *viz.*, in the slightly stronger impoverishment of strontium. Calculating the ratio in question from the three analyses of Table I and from Anal. No. V in Table XI, representing the only separate rapakivi samples from which both barium and strontium are determined quantitatively, the following results were obtained:

	BaO : SrO
Granite porphyry (boulder), Uomaa	100 : 6
Even-grained rapakivi granite, ab. 2 km N.W. of Koirinoja	100 : <8
Ovoidic rapakivi, Pensanoja	100 : 7
Rapakivi, Ihovaara	100 : 7

In accordance with the previous data about the abundance of rubidium in Finnish granites given by Erämetsä, Sahama and Kanula (1941), the average content of this element in the acid members of the East Fennoscandian rapakivi series is clearly greater than in granites in general. According to Goldschmidt, Bauer, and Witte (1934) the granites show 0.091 % Rb_2O on an average and this figure obviously does not lie very far from the respective average of the granites of the Finnish Archaean. As in the case of barium, rubidium too is enriched in the rapakivi granites. Here the enrichment is also relative, as well as absolute, in relation to potassium. Taking for granite the figure given by Daly (1933) of K_2O and that given by Goldschmidt, Bauer, and Witte *(l. c.)* of Rb_2O the following abundance relations can be set up:

	K_2O	Rb_2O	K_2O/Rb_2O
Granite	4.11	0.091	100 : 2.2
Rapakivi series	5.28	0.16	100 : 3.0

Because of the enrichment of rubidium in the rapakivi series a corresponding enrichment of caesium, too, might be expected. However, as mentioned above (p. 43), this element could not be established spectrographically, even in the infra red region where the sensitivity lies as far as 0.001 % Cs_2O. In harmony with the corresponding statement stressed by the author (1945) for the rocks of Southern Finnish Lapland, this fact indicates a considerable rarity of caesium in the Finnish Pre-Cambrian in general.

As for lithium, no previous data are available. The figure given above is exceedingly low when compared with that set up by Strock (1936) for granites on an average. In addition to the data given in Table I and XI this fact evidently shows that the rapakivi series in general shows a great lack of lithium. As stated by the author (1945) for the granitic rocks of Southern Finnish Lapland one has, however, to reckon with the possibility that the granites of the Finnish Pre-Cambrian in general contain considerably less lithium than the average mixture analyzed by Strock. At all events, the dearth of lithium in the rapakivi series is combined with a very low content of magnesium, which also is characteristic of the rapakivi series. According to Strock the concentration relation MgO : Li_2O lies at 100 : 6, but in the rapakivis this ratio is only 100 : 2.

The determination of lead having been made visually without any photometrical records, the result mentioned in Table VIII, *viz.*, 0.006 % PbO, means only that the respective content lies between the concentration steps 0.003 % and 0.01 % PbO. A comparison of the intensity of the strongest lead line in the spectrum of the rapakivi standard mixture with that of a number of Finnish Pre-Cambrian granites shows clearly that the abundance of lead in the rapakivi granites in general indisputably is greater than in other Finnish granites on an average. As mentioned by Sahama and Rankama (1938), lead is usually present in the youngest Archaean granites of the Finnish rock ground. In contrast thereto the older granites very often are completely devoid of lead.

With regard to the elements germanium, gallium, beryllium, boron, nickel, cobalt, chromium, and vanadium, the content found in the rapakivi standard mixture corresponds fairly well to the respective general averages of these elements in granites. They are not enriched, nor do they show any impoverishment in the rapakivi series. The same can apparently be said also of sulphur and carbon dioxide.

SUMMARY OF THE AVERAGE RAPAKIVI COMPOSITION.

The whole discussion above about the earlier data concerning the average chemical composition of the East Fennoscandian rapakivi granites was taken up in order to prove whether the standard rapakivi mixture made for the present purpose really corresponds to an average of the rocks in question. As will be perceived from Fig. 6 and from Tables VI and VIII the composition of the standard mixture does not lie far from the averages of Niggli, of Sederholm and of the recent analytical material. These three last-named averages are very close to one another in Fig. 6, but between them and the standard mixture there is a slight difference to be seen. This difference can be followed in detail by comparing Tables VI and VIII with each other. The most remarkable differences between the average based on the recent analytical material and the standard mixture are, for the main oxides, in the case of FeO and CaO. In the standard mixture the respective values are lower for both. The average of Sederholm differs in general a little more.

At any rate, the differences found between the standard mixture and the average of the recent material are not great. Therefore, there is good reason to consider the standard mixture as representative of the acidic rapakivi granites of Eastern Fennoscandia in general. In the present connection this statement is very important, because the results obtained in analysing the mixture for trace elements can thus be regarded as characteristic of the whole rock series in question.

When characterizing the chemical behaviour of igneous rocks in general Niggli (1923) has divided the different rock types in question into three main series, *viz.*, into a calci-alkalic, a sodic, and a potassic one. As for the rocks of a true acid granitic composition, the sodic series is represented by the alkali granitic type and the calc- alkali series by types which he calls aplitic and engadinitic. Of the potassic series the rapakivitic type is the most acid one. This division is purely descriptive but — as pointed out by Wahl — as such it is very illustrative. Certainly, the rapakivi granites show some special features which are foreign to other granitic rocks in general, but it must, however, be borne in mind that according to the division of Niggli all separate rocks belonging to the rapakivi series cannot be included in the potassic igneous rock suite proper. As a matter of fact, rapakivi granites sometimes show a composition of an engadinitic type as set up by Niggli. Thus there is no sharp boundary between the potassic and calci-alkalic series. As can be seen through a comparison of the averages of Table VII with the mean engadinitic rock type of Niggli, the respective differences are not very great. The corresponding differences between the sodic and other series are greater.

When setting up average figures for the content of different trace elements in various igneous rock groups, the acid members are mostly simply taken as »granites». This has, of course, been done in order to illustrate the general behaviour of a certain element in the course of a magmatic differentiation. The reasoning above I have presented, however, in order to point out that the characteristics in the content of the trace elements in the »granitic» rocks of different kind can well be expected to deviate from one another. For example, a sodic granite of an alkaline suite might very well show certain features quite foreign to a »granite» of a potassic one.

Certainly, there is no reason to regard the trace element content found for rapakivi granites in general as typical of all acid granitic rock types of the potassic suite. The average composition found in the present investigation is representative of the East Fennoscandian rapakivi granites only, and it cannot be generalized for any other rock groups. However, some features given in detail in the above pages are characteristic enough to be summarized here. Even if a generalization of them over other rock classes of a similar main composition is by no means justified, these features nevertheless seem to be worth noting in this connection.

As stated by all petrologists who have dealt with the chemical behaviour of the rapakivi granites, the most remarkable feature of the chemistry of these rocks is the enrichment of potassium. Hand in hand therewith a decline in calcium and magnesium is prominent. Now, if the rapakivi series is compared with other granitic rocks in the Finnish Pre-Cambrian, as well as with granites in general, a special enrichment of the following trace elements will be seen: fluorine, zirconium (and hafnium), barium, rubidium (and lead). Certainly all these belong to that group of elements which are highly characteristic of granitic rocks. There is, however, an exceedingly interesting fact in regard to the list presented here. As is known, the potassium ion has a very great radius, *viz.*, 1.33 Å. The last three of the elements mentioned above also show ionic dimensions of the same order of magnitude: $Ba^{\cdot\cdot}$ 1.43, $Rb^{\cdot}$ 1.49, $Pb^{\cdot\cdot}$ 1.32. Of the general geochemistry of these elements we know that they, in the course of a magmatic differentiation, readily enter into the lattices of potassium minerals and obviously substitute it isomorphously. The leading principle in the geochemistry of these elements, when occurring in silicatic surroundings, is a certain parallelism with the mode of occurrence of potassium. Thus, it is by no means surprising that just these elements are enriched in the potassium-rich rapakivi granites too. A parallel enrichment of potassium and these elements mentioned is quite natural. On the other hand, it is a remarkable circumstance that caesium, which might also be expected here, is practically absent.

In contrast hereto, fluorine and zirconium show in their general geochemistry no pronounced parallelism with potassium. Their exceptionally abundant occurrence together with it is obviously to be regarded as merely accidental and characteristic of the present rock series in especial, as well as of the corresponding Greenlandian and Swedish rapakivis according to Wegmann (1938) and, *e. g.*, to v. Eckermann (1936) respectively.

Among those trace elements of which the present rapakivi granites are especially devoid, lithium is to be mentioned. In its mode of occurrence this element shows a certain analogy with magnesium, of which the rapakivi granites also show a great lack.

The rare earths as well as tantalum are very abundant in the present rapakivi series, but they are not so exceedingly enriched in regard to the other Pre-Cambrian granites of Finland as the elements mentioned above.

In the general mode of occurrence of the East Fennoscandian rapakivi granites there is one feature of special interest, *viz.*, the lack of pegmatitic products. Certainly, at some places thin veinlets or other features have been found, indicating a tendency to pegmatitic crystallization of matter, but this phenomenon is evidently only a very great rarity and it is by no means typical of rapakivi granite *massifs*. Another phenomenon comparable with an occurrence of pegmatites is the abundant appearance of miarolitic cavities. In all rapakivi areas in East Fennoscandia as well as in other rapakivi regions these cavities have been met with and in some places they have been observed to contain topaz. As pointed out by Wegmann (1938), the lack of pegmatitic material in connection with the rapakivi granites is merely apparent. According to him the rapakivi granites are by no means devoid of pegmatitic solutions. These solutions have not been able to separate themselves out as well developed veins, but are to be found in the rapakivi material where they have reacted with the latter.

As shown by Rankama (1944) as regards tantalum, in the granites of Tammela those granites which evidently have produced pegmatitic solutions are sometimes richer in elements typical of pegmatites. The case pointed out by him is, certainly the only one proved as yet, but it indicates that there in this way are indeed possibilities to connect the pegmatites with fixed granites of the region. Accordingly, there is full reason to take seriously into account the possibility that the incorporation of pegmatitic material in the rapakivi granite proper might be reflected in the content of trace elements of the rock. As a matter of fact, the exceptionally high content of fluorine can evidently be explained in this way. Among the elements mentioned above also rubidium, rare earths, and tantalum are known to be of a specially pegmatitic nature. Their remarkable abundance is thus expressed in accordance with the idea of Wegmann. On the other hand neither zirconium nor barium are typical of pegmatites of granitic origin. As for barium (and lead) it is very characteristic of late magmatic solutions of pneumatolytic or of hydrothermal stages, but in pegmatites proper the element is not exceedingly enriched. As stressed by v. Engelhardt (1936), barium shows, on the contrary, a marked tendency to be enriched in potassium minerals like sanidine formed in relatively high temperatures. The phenomenon is well illustrated, *e. g.*, by the results reported by Groves (1935) in connection with the charnockites of Uganda. This circumstance is easily to be understood lattice-energetically in virtue of the higher charge of the barium ion. Zirconium certainly occurs as zircon in the pegmatites of nepheline syenitic and other sodic origin, but it is in general foreign to granite pegmatites proper. The enrichment of zirconium and barium in the rapakivi granites is thus not to be regarded as evidence of contamination of pegmatitic material in the rock series in question. — In many places — especially in the Viipuri area — galena has been established in smooth veins and the occurrence of these veins is very easily to be understood through the relatively high content of lead found in the rapakivis on an average.

As pointed out when setting up the problem of the present investigation, it is not my intention to search for any explanation of the genesis of the rapakivi granites and of their peculiar texture on the basis of the geochemical data expressed above. This question has been discussed in the last ten years very intensely by various authors, the ideas of Backlund having furnished the neccessary encouragement. Though no unanimity has been reached so far, it must be stated, however, that, without doubt, points of view presented in literature have at any rate thrown much light on this difficult problem. It is obvious that the question of the genesis of the rocks in question cannot be solved solely on the basis of their chemistry, but that this must be done in the main through tectonical, structural *etc.* observations in the field. The chemical composition is, of course, no absolutely binding evidence of a certain genesis for a rock or rock group, but, on the other hand, a given theory concerning the genesis of the rock or rock group in question must always enable us to explain the chemical composition too.

CONTACT BETWEEN RAPAKIVI GRANITE AND MICA GNEISS AT IHOVAARA HILL (SALMI AREA).

A very remarkable feature in the mode of occurrence of the rapakivi granites of the East Fennoscandian areas mentioned above, as well as in general, is their relation to the surrounding rock ground. The respective contacts are mostly sharp and unperturbated. In very many places where the exposures allow direct observations on the contact surfaces no veins entering from the rapakivi to the surrounding older rocks can be seen. In some other cases, however, a certain migmatitization is beautifully visible. Of such cases I should especially like to mention the migmatitization phenomena on the rapakivi contact in the Pellinge region on the small islands around Buckholm, thoroughly described by Sederholm (1923).

In the Salmi area the contact phenomena have been studied by Trüstedt (1907) in the Pitkäranta mining field and, besides, by the Russian geologists at Tulemajoki river, near the source of the river at Lake Tulemajärvi, at Palalahti on the north-eastern shore of Lake Tulemajärvi, and on the south-west shore of Lake Kavatjärvi (*cf.* Timofeev 1935). In the north-west contact of the Salmi area Eskola has found a very beautiful outcrop at the small wooded hill called Ihovaara on the maps. Professor Eskola was kind enough to tell me about this contact exposure and to show me the situation of it on the map. At his suggestion and in the pleasant company of Dr. Kalervo Rankama and Mr. Kauko Parras, M. A., of the Geological Survey, I paid a short visit to this interesting locality and collected some specimens of the rocks met with there. As the observations made at that place and especially the analyses carried out of the rocks may be of a certain interest, I shall in the following give a short description of the field relations and of a microscopical study of the rocks in question with additional analytical data.

The Ihovaara hill is situated about 5 km. west of the village of Maisula in the parish of Suistamo. The hill itself is wholly wooded up to the top, where the rocky summit is almost naked. The greatest part of this outcrop is occupied by a sedimentogeneous mica gneiss striking nearly east-west and dipping very steeply south. On the southern margin of the outcrop the rock is abruptly penetrated by the rapakivi granite. The contact surface is well exposed and the migmatitization phenomena described below can be followed from the contact until almost the top of the rocky summit of the hill at a distance of some 20—30 meters from the contact.

The mica gneiss at the Ihovara hill proper being very intensely affected by migmatitization and metasomatic addition of matter from the rapakivi granite, it did not seem be possible for a collection of samples of the gneiss certainly not affected by the rapakivi to be made there. In order to get a picture of the petrography and chemistry of the gneiss in an unchanged shape other outcrops were sought in the neighbourhood. The nearest outcrop known to the author lies about 1 km. east of the top of the hill. The gneiss found at this place was in the field petrographically almost identical with the gneiss found in the contact zone and it showed no traces of an immediate vicinity of a younger granitic intrusion. Therefore, the petrographical and chemical investigation of the mica gneiss in question was carried out by the aid of samples collected at this locality.

As in the outcrop at the top of the Ihovaara hill, also the mica gneiss at this last-named locality shows a marked banded texture. The banded appearance of the rock is emphasized on the weathered surface by the different corrosion of the separate bands, obviously due to a slight contamination of calcareous matter. As the most characteristic feature it is to be noted that some of the bands contain small oval-shaped knobs varying from about 1 to 10 cm. in length and lying with their long axis in the schistosity plane. In addition to quartz and feldspar, these knobs are composed of cordierite, garnet, andalusite, sillimanite, spinel, and a little staurolite, but they seem to be very devoid of mica. In other bands these knobs are lacking. Quartz with plagioclase and a little potash feldspar as well as biotite and muscovite and, additionally, apatite, ore, and minute traces of zircon form their constituents. The special aluminium-rich minerals mentioned above are also to be seen, but their amounts are considerably lower than in the layers containing knobs. The rock in question is seen in Fig. 8.

There is thus no doubt of the sedimentogeneous character of the mica gneiss. The average chemical composition of the rock is seen in Table XI, Anal. I.

According to the observations made in the field, the aluminium-rich mica gneiss in the contact outcrop at the top of Ihovaara hill seems to be identical with the rock from the above-mentioned place certainly not affected by the granite. When studying microscopically the gneiss obtained at different distances from the contact surface, it can, however, be seen that the aluminium-rich minerals disappear, or at least decrease in amount very considerably, when passing over towards the contact. The relatively light-coloured and beautifully brown biotite becomes darker, sometimes with a greenish tint, while the pleochroism becomes stronger. In the immediate vicinity of the contact surface and especially in the gneiss fragments floating in the rapakivi the rock is clearly recrystallized. The orientation of the biotite flakes is disturbed and the whole rock shows under the microscope a merely disorientated appearance. The amount of potash feldspar as well as sometimes of mica increases. The potash feldspar forces its way into the space between grains of quartz and plagioclase and, in a way, forms the binding material of the whole rock. Close to the contact some bands show a weakly reddish colour, due to an entering of potash feldspar into them.

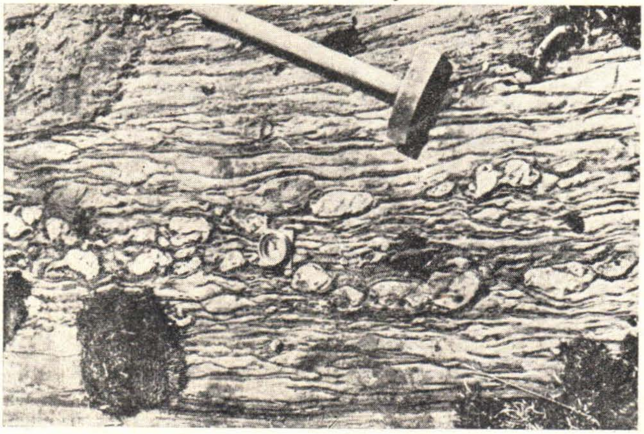

Fig. 8. Mica gneiss, Ihovaara, Parish of Suistamo.

As regards the gneiss lying immediately at the contact surface, Analysis II is presented in Table XI and Analysis III represents a gneiss fragment in rapakivi.

The rapakivi granite abruptly cutting the mica gneiss is clearly lying under the latter. The contact line is very sharp, without any traces of mineral formations along same. The rock fragments broken away from the gneiss wall and now floating in the rapakivi show thoroughly sharp-edged contours without any resorption phenomena. In the immediate vicinity of the contact there is no change in grain size or other phenomena indicating a more rapid crystallization of the matter to be seen in the rapakivi granite. A contamination of the contact rock with the adjacent sediment material is, however, evident, *e. g.*, through the slightly more abundant appearance of mica. The texture of the rapakivi granite is not very typical in the usual sense of the word. As will be perceived from Fig. 2, the rock is almost even-grained, the »pyterlitic» tendency being only slightly visible in the beginning development of some potash feldspar crystals into phenocrysts.

Of the »normal» rapakivi granite from about ten meters from the contact and of the contaminated rapakivi immediately at the contact the Analyses V and IV respectively are given in Table XI.

As mentioned above, there are very intense migmatitization phenomena to be seen in the vicinity of the contact surface in the mica gneiss, in a zone of some 20—30 meters in breadth. The rapakivi granite with its original texture and without any traces of fluidal movements has sent a great number of veins into the mica gneiss. These veins run partly parallel to the plane of schistosity and partly cut straight across the gneiss layers. In many places they have bored their way through, breaking the gneiss into fragments. In some other places it can be seen how the veins have lost their penetrative strength and form a smooth pocket in the gneiss, indicating that the rapakivi magma has been a very »lazy» one. Through the whole affected contact zone there are numerous small clumps of rapakivi representing those pockets, visible to-day on the rock surface, seemingly independent and irregular in appearance. Besides, the whole gneiss in the contact zone is often spattered with potash feldspar crystals one centimeter in size on an average. These potassium feldspar crystals are exactly like those of the rapakivi granite proper on the other sid of the contact, but they show in general better crystal forms. The phenomena mentioned above are illustrated in the figures of Plates I and II.

Methodical remarks on Table XI. The chemical determinations presented in the Table, *viz.*, SiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, Na_2O, K_2O, H_2O+, H_2O-, MnO, TiO_2, P_2O_5, and F, are the work of Dr. Lauri Lokka. All other data, were obtained spectrographically by the author. BaO, SrO, Rb_2O, Li_2O, CoO, NiO, BeO, Ga_2O_3, PbO, Cr_2O_3, V_2O_5, and the rare earths were determined as described above in connection with the rapakivi standard mixture. However, the determinations of ZrO_2 and B_2O_3 were carried out only visually, without any photometrical records. In addition, it is to be mentioned that for the determination of zirconium no chemical pre-enrichment was made. The estimate was effected on the basis of optical spectra. The determination of Nb_2O_5 too was performed without any chemical pre-treatment.

In Table XII the molecular proportions and Niggli values are given.

The rock samples which are analysed in Table XI represent a series beginning from an unchanged sedimentogeneous mica gneiss over a slightly affected contact variety of it, to a metasomatically considerably altered gneiss fragment in the rapakivi granite. Further, the series is continued over a contaminated contact variety of the rapakivi granite to a »normal» one lying outside the contact zone. The metasomatic addition of material from the rapakivi granite to the mica gneiss being evident in the field, the question now arises how the different elements have wandered during the whole process. This wandering is in some points very illustrative.

As for the rapakivi granite lying about ten meters from the contact surface and designated above as a »normal» rapakivi, a comparison will be made with the general rapakivi composition. The *si* value calculated from the analysis of the Ihovaara rock (Anal. V in Table XII) is 461. Due to the small scale of the figure, the separate points of a certain analysis in Fig. 6 are certainly not always easily to be distinguished from the respective points of the neighbouring analyses. However, if one takes into

Table XI. Analysis of rocks from the contact between rapakivi and mica schist at Ihovaara hill. Chemical determinations by Lauri Lokka, spectographical by the author.

	I Mica gneiss. Ab. 1 km E. of the Ihovaara hill.	II Mica gneiss from the immediate vicinity of the rapakivi contact. Ihovaara.	III Mica gneiss fragment in rapakivi. Ihovaara.	IV Contaminated rapakivi from the contact. Ihovaara.	V »Normal» rapakivi granite. Ihovaara.
SiO_2	60.31	64.60	59.73	71.95	74.76
Al_2O_3	17.82	17.25	18.19	15.07	12.93
Fe_2O_3	1.68	0.96	0.65	0.72	0.40
FeO	5.69	4.18	5.90	1.69	1.51
MgO	2.13	1.65	2.02	0.09	0.14
CaO	2.16	1.23	1.81	0.82	0.10
Na_2O	3.35	3.58	3.78	2.95	2.56
K_2O	3.53	3.80	5.41	5.40	6.14
H_2O+	1.61	1.88	0.79	0.80	0.69
H_2O-	0.13	0.14	0.11	0.09	0.10
MnO	0.09	0.03	0.02	0.01	0.01
TiO_2	0.91	0.59	0.83	0.33	0.30
ZrO_2	0.01	0.01	0.01	0.1	0.1
P_2O_5	0.27	0.18	0.21	0.12	0.13
F	0.03	0.03	0.25	0.05	0.04
BaO	0.16	0.082	0.076	0.071	0.054
SrO	0.04	0.033	0.019	0.007	0.004
Rb_2O	0.07	0.06	0.12	0.17	0.11
Li_2O	0.0089	0.033	0.023	0.0044	0.0052
CoO	0.001	0.001	0.001	0	0
NiO	0.001	0.0003	0.0003	< 0.0003	0
BeO	0	0.001	0.0003	0	0
Ga_2O_3	0.01	0.01	0.01	0.01	0.01
PbO	0.003	0.001	0.001	0.001	0.001
B_2O_3	0.01	0.01	0.01	0.01	0.003
Cr_2O_3	0.03	0.02	0.01	0.006	0.004
V_2O_5	0.03	0.03	0.03	0.003	0.0003
La_2O_3	0.0013	0.0030	0.0023	0.0038	0.0046
Ce_2O_3	0.0033	0.0055	0.0041	0.0060	0.0100
Pr_2O_3	0.0006	0.0013	0.0011	0.0016	0.0015
Nd_2O_3	0.0028	0.0032	0.0026	0.0038	0.0041
Sm_2O_3	0.0006	0.0009	0.0009	0.0008	0.0015
Gd_2O_3	0.0009	0.0010	0.0008	0.0011	0.0024
Dy_2O_3	0.0003	0.0005	0.0006	0.0007	0.0009
Er_2O_3	0.0002	0.0004	0.0005	0.0003	0.0007
Yb_2O_3	< 0.0001	0.0003	< 0.0004	< 0.0003	0.0007
Y_2O_3	0.0025	0.0033	0.0019	0.0020	0.0052
Sum R. E.	0.0126	0.0194	0.0151	0.0203	0.0316
Sc_2O_3	< 0.0001	0	< 0.0001	0.0001	0.0001
Nb_2O_5	0.001	< 0.001	0.001	0.003	0.003
Sp. gr.	2.743	2.687	2.740	2.566	2.597

consideration the figures for the Niggli values of the Ihovaara rock presented in Table XII, it can be seen in Fig. 6 that the values of *fm* and *alk* lie very near to the respective average curves indicated in the figure. In contrast thereto the values of *c* and *al* deviate very considerably from the curves. The value of *c* is remarkably low and that of *al* very high. This

Table XII. Molecular proportions and Niggli values of the analyses in Table XI.

	I	II	III	IV	V
SiO_2	1 000	1 071	990	1 193	1 240
Al_2O_3	174	169	178	148	127
Fe_2O_3	11	6	4	5	3
FeO	79	58	82	24	21
MgO	53	41	50	2	4
CaO	39	22	32	15	2
Na_2O	54	58	61	48	41
K_2O	38	40	57	57	65
H_2O+	89	104	44	44	38
MnO	1	—	—	—	—
TiO_2	11	7	10	4	4
P_2O_5	2	1	2	1	1
F	2	2	13	3	2
Rb_2O	—	—	1	1	1
si	218	266	211	395	461
al	38	42	38	49	48
fm	34	28	30	12	12
c	8	6	7	5	1
alk	20	24	25	34	39
k	0.41	0.41	0.48	0.54	0.62
mg	0.34	0.38	0.36	0.05	0.13
c/fm	0.23	0.21	0.23	0.42	0.08

fact, depending on the exceedingly low content of CaO of the rock in question, is very characteristic of the Ihovaara rapakivi. As found by microscopical examination of the rock, the amount of plagioclase is very small and the composition of it according to its optics seems to be very albitic. Thus, the amount and composition of the plagioclase in the rock obviously is in accordance with the low calcium content. Taking into consideration the fact that according to Tschirwinsky (1928) the potash feldspars of granitic rocks contain on an average about one per cent CaO, the absence of calcium in the Ihovaara rock is indeed very surprising. On the other hand I have no reason to doubt the correctness of the respective calcium determination. In any case it is evident that the Ihovaara rock is extraordinarily poor in calcium.

In order to get a view of the variation of the components through the analysis series shown in Table XI, Fig. 9 may be presented. In it the highest figure of a certain oxide in all five analyses was taken as mass and the other figures for the same oxide were reduced to a corresponding amount. The respective values are shown graphically in the figure. The vertical black line there is proportional to the amount of the component in question and the variation of it through the rock series indicates the relative change in the amount of the oxide. The broken line combining the vertical black lines characterizes the strength of the increase or decrease of a certain oxide through the whole rock series.

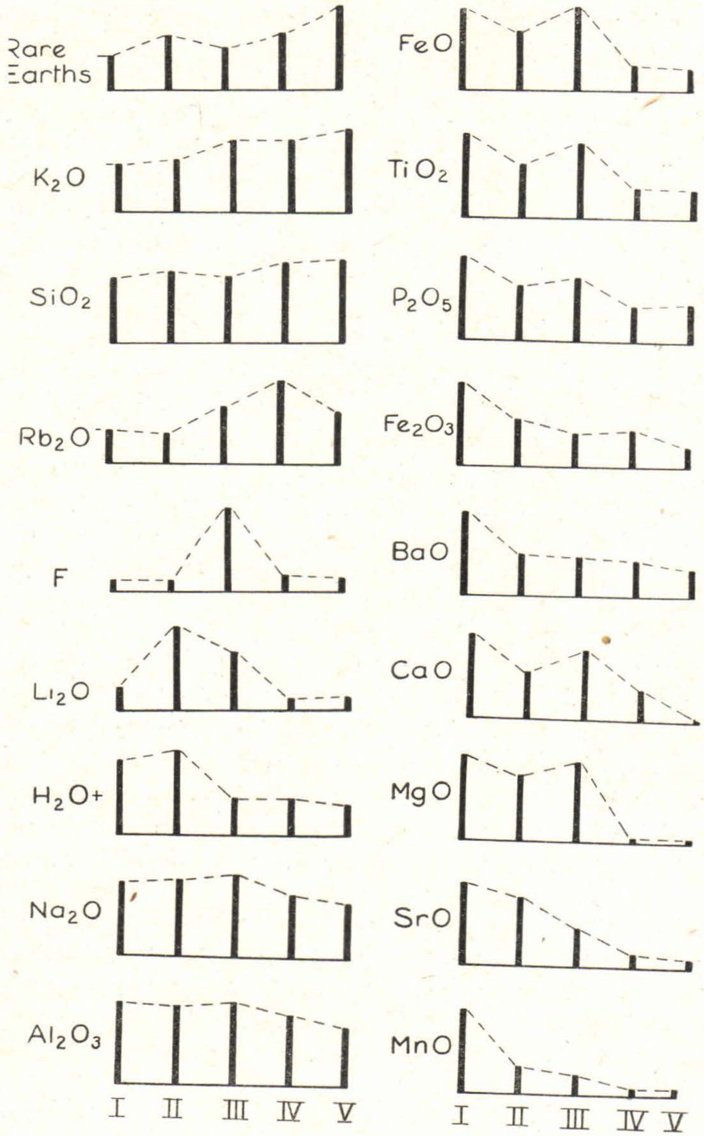

Fig. 9. Variation of the different oxides in the Ihovaara rocks according to Table XI. I Normal mica gneiss. II Mica gneiss from the rapakivi contact. III Mica gneiss fragment in rapakivi. IV Contaminated rapakivi. V Normal rapakivi.

In Fig. 9 only such components are included which have been determined chemically or by means of spectrum analysis with photometrical records. The spectrographical determinations carried out through visual estimations with standard spectra being relatively inaccurate, these determinations were not taken into account in the figure. The consideration of them needed in the discussion below is performed simply on the basis of the figures presented in Table XI.

As will be perceived from the figure, the different components can be subdivided into two groups. To the first group, characterized through a continual increase of the compound in question when passing over from the unaltered mica gneiss to the normal rapakivi granite, belong the rare earths, potassium and silicium. The enrichment of these components in the rapakivi in regard to the mica gneiss is strongest for the rare earths. The other group involves manganese, strontium, magnesium, calcium, barium, ferric iron, phosphorus, titanium, ferrous iron, aluminium, sodium, and water. For these compounds the tendency in question is contradictory in regard to the first group. In the normal as well as in the contaminated rapakivi these compounds are less abundant than in the mica gneiss and in its altered varieties. Between the two groups mentioned there is to be seen a third one representing a certain transition between them. The elements in question — rubidium, fluorine, and lithium — are most abundant in the contact zone. For these three elements an interesting series can be seen. Rubidium is most abundant in the contaminated rapakivi, fluorine in the gneiss fragment floating in the rapakivi, and lithium in the contact variety of the mica gneiss. These three elements obviously having been metasomatically introduced from the rapakivi to the surrounding gneiss, lithium thus shows a relatively stronger mobility in this case than do fluorine and rubidium. It has evidently wandered a step farther than the latter. Rubidium, on the other hand, has been the most steady of the three. — The difference in the content of the gneiss and the rapakivi is greatest for manganese, strontium, magnesium, and calcium.

As to elements determined only through a visual estimation of the spectrum lines with corresponding standard spectra, the two groups can also be detected. To the first group — most abundant in the rapakivi end of the series — belong zirconium, scandium, and niobium. The second group includes cobalt, nickel, beryllium, chromium, and vanadium as well as boron and possibly lead. The comparative abundance of Zr, Sc, and Nb as well as the absence of Co, Ni, Cr, and V in the rapakivi end of the rocks is quite natural and needs no further comment. The circumstance that Be and B are obviously less abundant in the rapakivis is very remarkable because of the pegmatitic nature of both these elements. It could be expected that these elements would, on the contrary, be enriched in the rapakivi. For beryllium the matter might be explained through the remarkable impoverishment of aluminium in the rapakivi and, for boron, on the other hand through the sedimentogeneous nature of the mica gneiss.

The presented facts of the introduction of the elements from rapakivi to mica gneiss in the rocks of the contact outcrop of Ihovaara are evident. The picture of the matter given in Fig. 9 is a fixed one prevailing in this case only. A very interesting task would now be to investigate how the matter stands in rapakivi contacts of other kinds, *i. e.*, in cases where a rapakivi granite lies in contact with other rocks. It is quite easily possible that some compounds would then show corresponding curves different from that in the present case. If observation material of this kind were larger, conclusions as to the general mobility of the elements in a beginning granitization of rocks could possibly be drawn. Because of the lack of such material from the rapakivi contacts — and also from other granitic contacts — I will, however, not continue this discussion any further at present.

SUMMARY.

In the present paper an attempt has been made to collect together the most important data about the general chemistry of the East Fennoscandian rapakivi granites. Seeing that acidic members predominate in the series in question, attention has been mostly paid to them. The problem being confined to the consideration of the general chemistry only, the regional or local details were overlooked.

A very short review of the areal distribution as well as of the textural and mineralogical features is given on the basis of literature.

Some additional data of the Salmi rapakivi *massif* are given. One characteristic specimen of each of the three main textural types is described both petrographically and in regard to its chemical composition.

All the chemical analyses of the East Fennoscandian rapakivi granites found in literature which obviously are dependable enough for the purpose and, besides, represent typical varieties of the rock series in question were collected together and an average of them calculated. This figure is compared with the analysis series used for the calculation as well as with the mean rapakivi compositions earlier presented by various authors. The following statements were made:

The East Fennoscandian rapakivi granites represent chemically a continuous rock series in which the composition gradually changes.

When compared with other granitic rocks the rapakivi granites — as already previously known — contain more SiO_2 and K_2O, and less MgO, CaO, as well as Al_2O_3.

In order to get a view of the general content of the trace elements a standard mixture of the East Fennoscandian rapakivi granites has been made. This mixture has been analyzed chemically and spectrographically. A comparison of the mixture with the average rapakivi composition calculated above shows that the mixture really is to be regarded as comparatively representative of the rock series in question. Thus the most characteristic features in the contents of trace elements were deduced on the

basis of the composition of this mixture. Especially enriched in the rapakivi granites of East Fennoscandia are: F, Zr (and Hf), Ba, Rb, Pb; comparatively enriched: Ta and rare earths. The rapakivi granites show a great dearth of Li and Cs. The abundance of the various trace elements and the concentration relations of some of them are discussed. The difference in the content of trace elements between rapakivi granites and other granitic rocks of the Finnish Archaean is stressed.

The rocks at the contact between rapakivi granite and a sedimentogeneous mica gneiss at Ihovaara hill (N.W.- boundary of the Salmi area) were studied. The outcrop in question is described. An analysis series representing the different rock types from normal rapakivi granite to an unchanged mica gneiss is given. The migration of the elements in the contact zone is discussed.

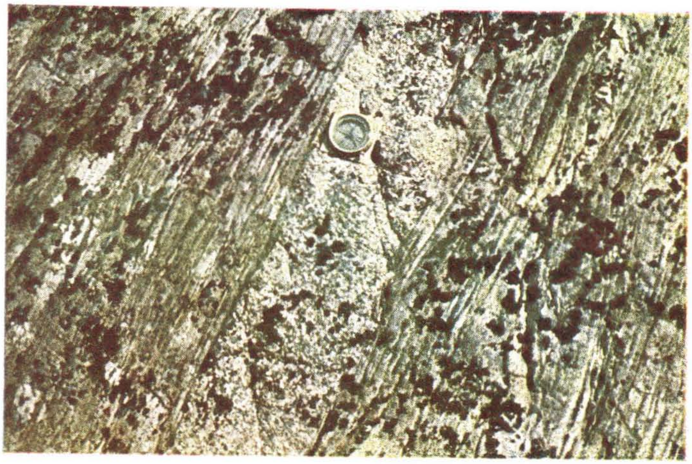

Fig. 1. Dyke of rapakivi granite in banded mica gneiss. Ihovaara hill, Parish of Suistamo, Salmi area.

Fig. 2. Rapakivi dyke brecciating mica gneiss. Ihovaara hill, Parish of Suistamo, Salmi area.

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Fig. 1. Pocket of rapakivi granite in mica gneiss. Ihovaara hill, Parish of Suistamo, Salmi area.

Fig. 2. Mica gneiss spattered with reddish potassium feldspar crystals. Ihovaara hill, Parish of Suistamo, Salmi area.

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