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POSSIBLE IMPACT METAMORPHIC TEXTURES IN THE ERRATICS OF THE LAKE SÄÄKSJÄRVI AREA IN SOUTHWESTERN FINLAND

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ABSTRACT

Erratics, which show textural similarities with impact metamorphic rocks, have been found in the area of Lake Sääksjärvi in the commune of Kokemäki, southwestern Finland. The preliminary study reports planar structures of quartz, kink-bands and oxidation of biotites as well as transformations of plagioclase, all of which characterize impact metamorphism.

Introduction

Some unmetamorphic volcanite-resembling erratics have been found on the eastern shores of Lake Sääksjärvi and in the gravel excavations of Karhiniemi. Mineralogist Y. Vuorelainen has also found some agate blocks coexisting with vesicular, porphyritic rocks in Karhiniemi. Upon closer examination part of the volcanite-resembling samples were found to have textures typical of extrusive rocks, whereas the other blocks were brecciated, strongly oxidated and some textural similarities were noted with impact metamorphic rocks as described by Chao (1967). This preliminary note reports only the possible impact metamorphic textures found in the blocks of Sääksjärvi and Karhiniemi.

Lake Sääksjärvi is situated in southwestern Finland about 25 km east of the town of Pori (Fig. 1). Karhiniemi, the place of discovery of most of the agates and volcanite-resembling blocks, is a small glacial esker in the northern part of the commune of Huittinen, some 20 km SE of Lake Sääksjärvi. The numerous gravel excavations of Karhiniemi have been favourable places for studying erratics and for findig agates and other interesting blocks. These boulders have also been found here and there in the moraine cuts of the small road between Karhiniemi and Sääksjärvi as well as in the roadcuts east of Sääksjärvi.

The boulder-rich shorelines on the eastern side of Lake Sääksjärvi contain some boulders resembling those described here, but only in small amounts evidently owing to the easy weathering of this rock type. The sizes of the boulders found vary up to 0.5 m in diameter and they always have roundish external forms.

The direction of the glacier movements measured from the striations north of Sääksjärvi is

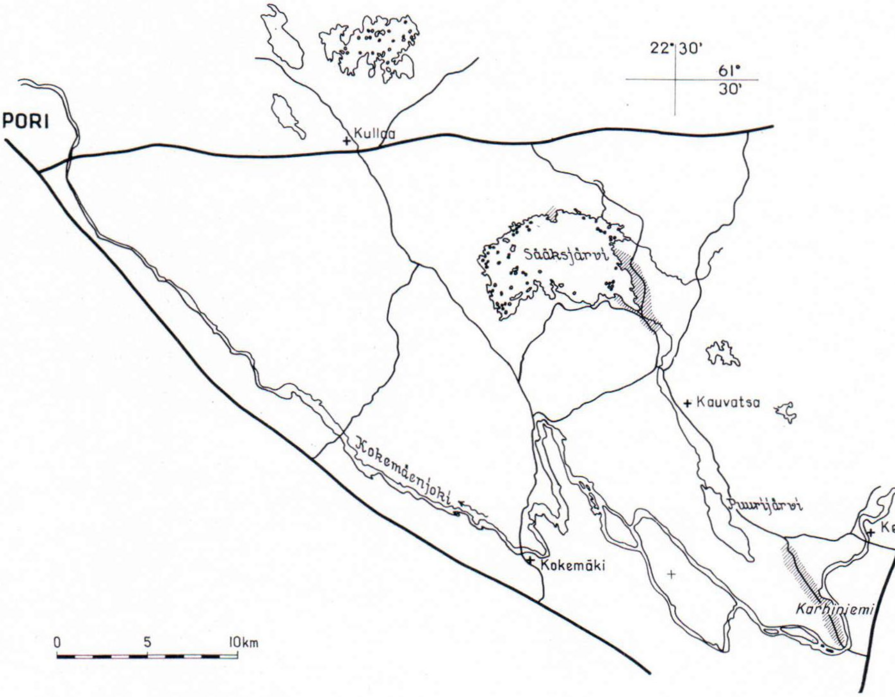

Fig. 1. Location of Lake Sääksjärvi. Shaded areas are places of discovery of impactites.

about 290° but the direction of the Karhiniemi esker is about 330°.

The bedrocks of the Lake Sääksjärvi area are mainly gneissose quartz- and granodiorite and veined gneiss. The special rock types described here have been found as erratics but nowhere as exposed bedrock. As the erratics have been found in the area east and southeast of Lake Sääksjärvi but not in the area west of the lake, it is evident that the erratics originate from the Lake Sääksjärvi area. The lake itself is open in the middle and eastern parts (Fig. 1). On the map the small capes in the southern part of the lake and also the eastern and northern shorelines indicate the circular form of the main body of the lake. In this respect Lake Sääksjärvi resembles those lakes of Fennoscandia, which have previously been suggested as ancient meteorite impact craters, namely Lakes Mien, Hummeln, Lappajärvi and Dellen (Svensson and Wickman 1965, Svensson 1966, 1968 a, 1968 b).

Description of the rocks

On the basis of their external characteristics the peculiar, volcanite-resembling boulders can be grouped as follows:

1. Dark greenish gray porphyritic rocks with small dark green amygdales. The rock resembles a typical lava rock with plagioclase phenocrysts; the groundmass is a partly cryptocrystalline brownish mass, partly composed of minute plagioclase, green biotite and occasionally also of hornblende and pyroxene prisms. Quartz occur sporadically as roundish, finegrained aggregates. The zonal amygdales are composed mainly of biotite-like green sheet silicate, of zeolites and rarely of quartz. This rock type resembles the common andesite or dasite.

2. Light brown vesicular boulders megascopically characterized by numerous brecciated fragments of gneissose or granitic rocks. The vesicles

are either open or, in some of the rocks, filled with zeolites and/or agate-forming silica (Fig. 2). The light brown groundmass is mainly cryptocrystalline, occasionally almost glassy. The phenocrysts are mainly plagioclase, potash feldspar, quartz and rarely spinel. The brecciated fragments of gneiss are composed mainly of quartz, strongly transformed plagioclase and oxidated biotite. The quartz of the fragments often shows multiple sets of closely spaced planar structures.

3. Dark brown brecciated boulders which do not contain open vesicles. Megascopically they are characterized by a black iron oxide-rich groundmass, which is either glassy or cryptocrystalline. The biotite is totally oxidized (Fig. 3). Small-grained quartz and zeolites occur as phenocrysts and numerous roundish and irregular pores are filled with zeolites. Zeolites alone are the main minerals of this rock type. It differs from type 2 mainly in the high content of black oxide matter in the groundmass (Fig. 4). Quartz with planar structures is abundant even in this type of rock.

4. The fourth rock type resembles megascopically a porphyritic gneiss or granite porphyry. Intense brecciation causes, however, a pseudoporphyritic texture, where quartz, plagioclase, potash feldspar and biotite occur as phenocrysts in a cryptocrystalline, occassionally glassy matrix. The plagioclase grains are strongly deformed, occasionally also transformed into plagioclase glass. The quartz shows multiple sets of planar structures (Fig. 5) and biotite is characterized by weak pleochroism, low birefrigence and numerous kink bands (Fig. 6).

Criteria for the meteorite impact metamorphism of the rocks

In his fundamental paper Chao (1967) gives the basic concepts for the criteria characterizing hypervelocity meteorite impact metamorphism. If the present samples are studied on this basis

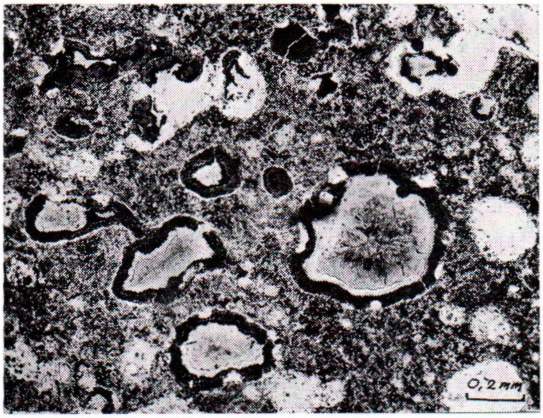

Fig. 2. Amygdaloidal rock, amygdules are filled with biotite, zeolites and silica. One nicol.

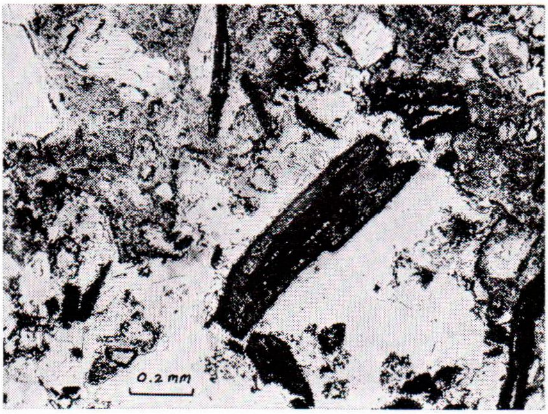

Fig. 3. Strongly oxidated biotite flakes, one nicol.

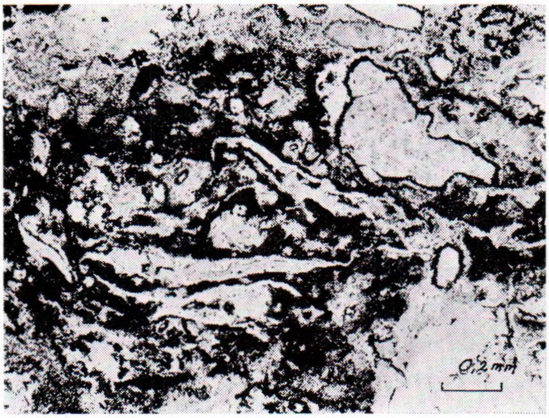

Fig. 4. A rock with an iron oxide-rich groundmass; light areas were formerly vesicles, now zeolite-amygdules (roundish and schlieren), parallel nicols.

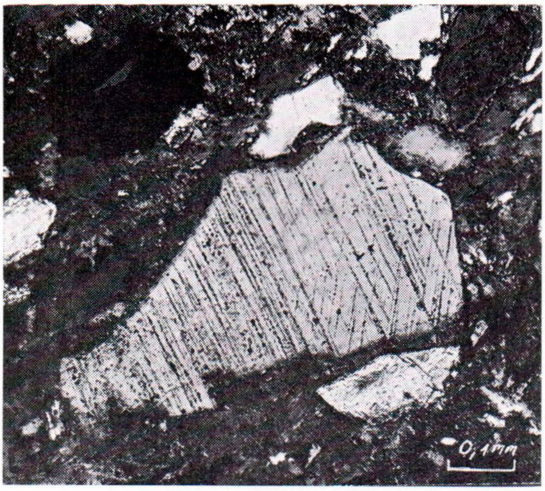

Fig. 5. Multiple sets of closely-spaced planar structures in a quartz grain. The rock belongs to type 4. Crossed nicols.

Fig. 6. Kink bands of biotite, one nicol.

it is noticed that in quartz there are multiple sets of closely spaced planar structures (Fig. 5), which in one sample have been measured as (1013), (01$\bar{1}$3) and (0001). This kind of planar structure of quartz has alone been considered as a criterion for meteorite impact metamorphism by Svensson (1968 b). The uniqueness of the planar structures to the astrotectonic deformation has been discussed by Greenwood (1967) and by McCall (1968). Carter (1968), however, states that planar features appear to be both characteristic of and reliable criteria for quartz deformed by shock due to impact by meteorite or comet.

The kink bands of biotite with reduced birefrigence characterize the moderately shocked granite gneisses of the Ries Crater, Germany (Chao 1967). Though the kink bands of biotite in general are not exclusively of shock origin, the observed kinked biotites of the present fourth rock type (Fig. 6) agree well with the other marks of impact metamorphism, as do also the oxidized biotite flakes and totally decomposed biotites of the second and third rock types (Fig. 3 and 4). This kind of rock is moderately or strongly shocked if compared with the shocked granite gneisses of the Ries Crater as described by Chao (1967).

The partial transformation of plagioclase into plagioclase glass along and across twinning lamellae is a mark of weakly shocked rock as are also the planar structures destroying the twinning lamellae as in Fig. 7.

Chao (1967) mentions strongly vesiculated textures as a textural characteristic of strongly shocked impact metamorphism. These also characterize some of the rock types described here, if one considers that zeolite and silica amygdales were formerly vesicles (Fig. 2).

As a specially interesting feature it should also be mentioned that according to quantitative X-

Fig. 7. A planar structure in plagioclase which has destroyed the twinning lamellae, crossed nicols.

ray fluorecence analysis some rocks of the first type described here gave nickel contents four to five times higher than the fourth rock type, which evidently represents the weakly shocked rocks.

The features and structures described above well warrant the supposition that the blocks originate from a meteorite impact crater. As Lake Sääksjärvi is well-fitted as the locality of provenance of the glacial boulder fan, and as its circular, open form is also suitable for that of crater, it is possible that Sääksjärvi itself is an ancient meteorite impact crater. An another possible origin of the blocks and the crater form of Lake Sääksjärvi is the volcanic explosion, which has been suggested as the cause of some Canadian craters by Currie and Shafiqullah (1968).

This is only a preliminary report of the peculiar erratics of the Lake Sääksjärvi area. The mineralogy, petrology and chemistry of the blocks as well as the geology of the Lake Sääksjärvi area will be studied in a more detailed way later, in order to establish the origin of the blocks and Lake Sääksjärvi.

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