An astroblematic contact granite/sandstone

SVEN HJELMQVIST

Hjelmqvist, S. 1977 09 15: An astroblematic contact granite/sandstone. *Bulletin of the Geological Institutions of the University of Uppsala,* N. S., Vol. 7, pp. 67—70. Uppsala. ISSN 0302-2749.

A seemingly intrusive contact of granite with a younger sandstone from the Siljan structure, central Sweden, is probably formed by a meteorite impact. Thin sections of both granite and sandstone show planar elements, and the sandstone, too, displays a small shatter cone.

Sven Hjelmqvist, Geologiska institutionen, Lunds universitet, Sölvegatan 13, S-223 62 Lund, Sweden, 4th April, 1977.

According to most geologists familiar with the problem the remarkable circular structure north of Lake Siljan in Dalarna, the so-called Siljan ring, is probably the result of a meteorite impact of enormous power, at which — within a ring-shaped belt with an outer diameter of about 45 km — the layered Palaeozoic rocks have been up-raised and overturned and frequently separated from the older bedrock by faults. Inverted layers also occur and portions of older bedrock can be found penetrating younger rocks. On the whole the tectonic is very complicated with numerous faults in varying directions (Hjelmqvist 1966, Fig. 116).

The interpretation of the Siljan ring as an astrobleme was first put forward as a tentative hypothesis by Fredriksson & Wickman (1963). Since then a good deal of facts have been known which more unanimously point to an impact origin of the structure. In 1970 P. B. Robertson and N. B. Svensson observed shatter cones in the central part of the structure (Svensson 1973), and in the following year a boulder of a very well developed shatter cone in a coarse granite was found by E. Chao about 8 km south of the former locality (Thorslund 1975). N. B. Svensson also reports the occurrence of planar elements in the granite (1971). P. Thorslund & C. Auton (1975) describe distorted and shocked fossils from the outer, Palaeozoic belt, and J. Rondot points out the great similarities existing between the Siljan structure and Charlevoix in Canada (1975). He emphasizes, int. al., the presence in both places of breccia dykes, so-called mylolisthenites, which had earlier been observed on the shore of Lake Siljan.

At field work in 1956 for the geological map of Kopparberg County the present author found in a new road cut south of Grunuberg inclusions of fine-grained sandstone in a red, medium to coarse-grained granite belonging to the Dala Granite Group. The latter also sent in narrow, coarse-grained veins into the sandstone, which seemed to be little influenced, showing no sign of contact metamorphism (1966, Fig. 62). The sandstone was then thought to belong to the Digerberg rocks, though very similar to a Jotnian sandstone. A small shatter cone was also observed in the sandstone (see Fig. 2). The collected material was put aside for future investigation.

The mentioned locality, in Fig. 1 marked with a cross, is situated about 1 km E of Hättberg and 500 m W of the recently preserved granite hillock with shatter cones SE of the small tarn Hättjärn (Thorslund 1975). The place lies about 5 km NW of the centre of the Siljan ring.

At the locality is now (1976) not much to see. Granite and sandstone appear certainly on the road side but their mutual relationship is scarcely discernible. When the road cut was still comparatively well exposed, it was possible to observe among the sandstone fragments also a piece measuring more than 2 m in length.

At the first glance the exposure gave the impression of being a normal intrusive contact, as the granite contains fragments of the sandstone and sends in veins into the latter. But against this speak the following facts. The granite shows no common decrease in grain size towards the contact. The small veins are in part coarse-grained although conspicuously inequigranular and consist, moreover, of feldspar and quartz which alternate in a very irregular matter. The sandstone has a well preserved clastic texture and shows no meta-

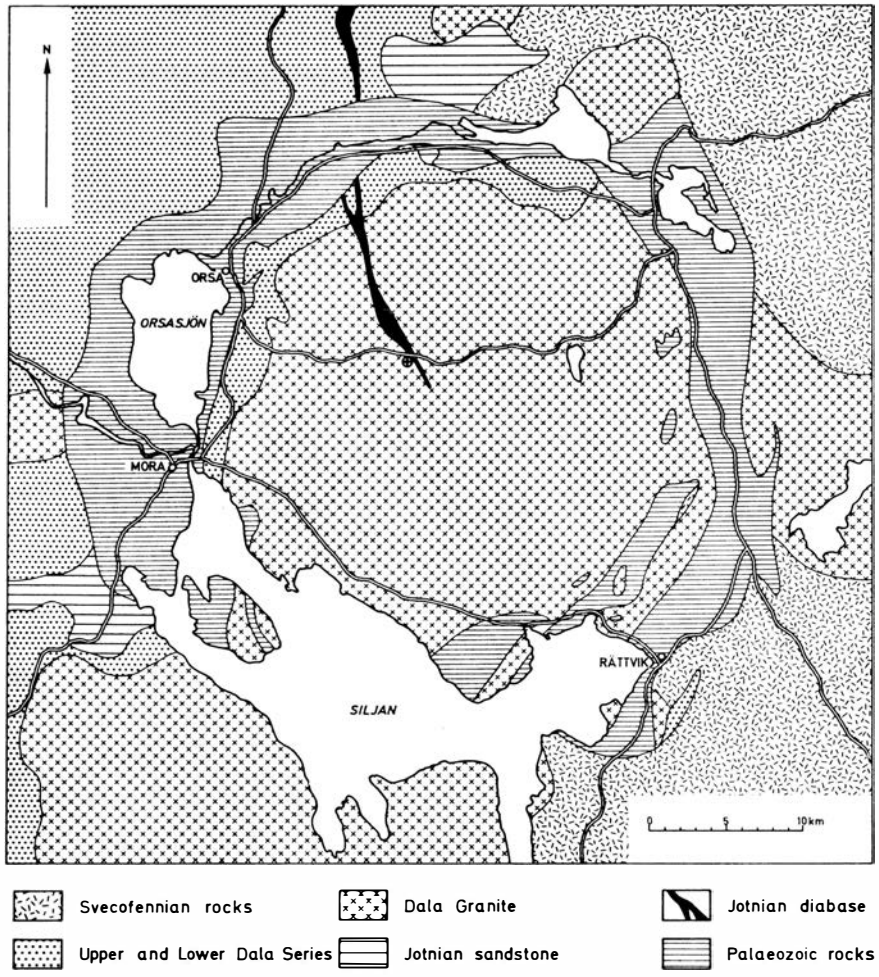

Fig. 1. Geological map of the Siljan ring. The cross in the centre of the map marks the described locality.

morphic influence by the granite. In the western part of the same granite massif a contact of quite a different kind occurs, where the granite contains rounded, rather diffusely defined fragments of an obviously older quartzitic sandstone, which is metamorphosed and at the contact contains large, newly-formed feldspar crystals. The quartzitic sandstone at this locality also appears as isolated, massive layers in the granite.

The granite E of Hättberg is a typical Dala granite with 4—10 mm large grains of flesh-red microcline and somewhat smaller grains of white plagioclase and quartz. Under the microscope it shows a granoblastic texture. The main minerals are quartz, microcline-perthite, oligoclase, and biotite-chlorite. Individual oligoclases sometimes are broadly tabular. Accessory minerals are apatite, sphene, epidote, orthite, muscovite, fluorite, zircon, and ore minerals. The quartz frequently is strongly undulatory and also shows closely spaced planar elements (Fig. 3), generally following the crystallographic planes $(10\bar{1}3)$, $(01\bar{1}3)$ and (0001). By exception planar elements are seen in the microcline-perthite in isolated spots.

The boundary between the granite and the sandstone is uneven and sometimes emphasized by an enrichment of quartz in a narrow zone without dark minerals (Fig. 4). In the specimen pictured in Fig. 4 this seam richer in quartz has a thickness of 0—6 mm. Beyond it the granite shows a local enrichment of chlorite in a narrowing belt 2—20 mm wide, suggesting that the granite was

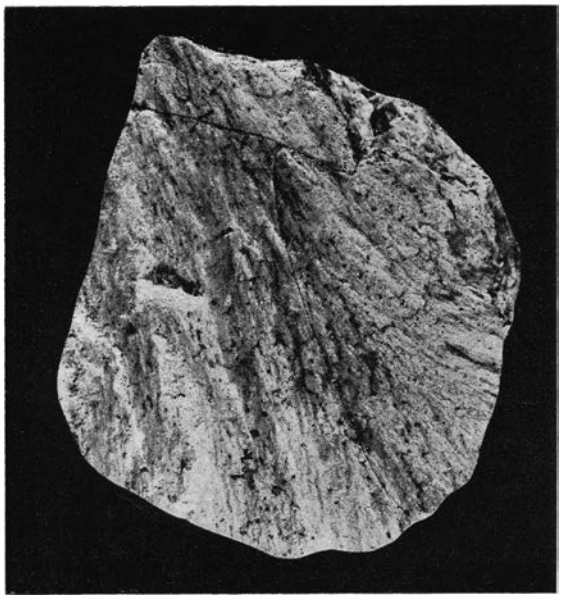

Fig. 2. Small shatter cone in sandstone, bordering on granite, 1 km E of Hättberg. Nat. size.

weathered before it came into contact with the sandstone. The grain size of this zone is only 1—4 mm. After that the coarse-grained granite follows. In other cases the coarse-grained granite borders immediately on the sandstone with an unevenly winding boundary without any transition zone.

The sandstone is fine-grained and has a well preserved clastic texture with rounded quartz grains 0,2—0,3 mm in size. The microscopic appearance is very similar to that of the Jotnian sandstone at Skattungbyn 13 km to the north just outside the granite boundary. Main minerals are quartz, microcline, and oligoclase, the latter filling the space between the quartz grains. In small amounts chlorite, muscovite, epidote, apatite, sphene, zircon, and ore minerals are present. The quartz shows the same planar elements as in the granite although less pronounced (Fig. 5).

The fact that the granite seems to have been weathered before the deposition of the sandstone makes it probable that some form of weathering breccia may have existed between granite and sandstone already before the possible impact and that this has facilitated the penetration of the granite into the sandstone, thus giving the impression of an intrusive contact.

According to Thorslund (in Rondot 1975) the thickness of the Palaeozoic cover which has been moved away from the inner part of the Siljan

Fig. 3. Granite showing planar elements in quartz. 20 ×.

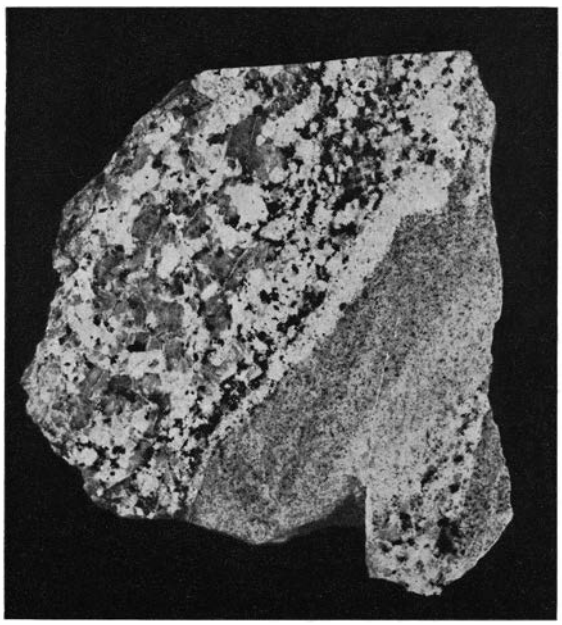

Fig. 4. Contact of coarse-grained granite with fine-grained sandstone, 1 km E of Hättberg. 4/5.

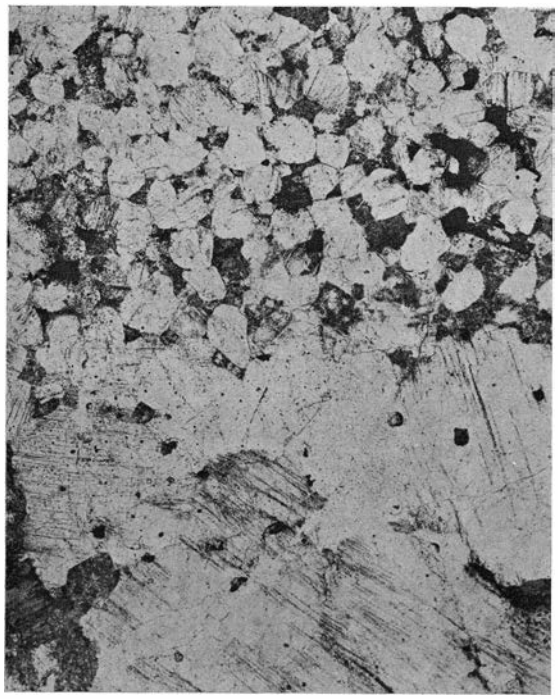

Fig. 5. Contact of granite with sandstone, both showing planar elements. 20 ×.

ring was 400—500 m. To this the Jotnian sediments must be added, the thickness of which, however, it not known in this region. Probably it does not change the above-named, rather approximative figure too much.

REFERENCES

Fredriksson, K. & Wickman, F. E. 1963: Meteoriter. *Svensk Naturvetenskap 16.* Stockholm.

Hjelmqvist, S. 1966: Beskrivning till berggrundskarta över Kopparbergs län. *Sver. Geol. Unders. Ca 40.* Stockholm.

Rondot, J. 1975: Comparaison entre les astroblèmes de Siljan, Suède, et de Charlevoix, Québec. *Bull. Geol. Inst. Univ. Upps., N. S. 6.* Uppsala.

Svensson, N. B. 1971: Probable meteorite impact crater in central Sweden. *Nat. Phys. Sci. 229.* London.

Svensson, N. B. 1973: Shatter cones from the Siljan structure, central Sweden. *Geol. Fören. Stockh. Förh. 95.* Stockholm.

Thorslund, P. & Auton, C. 1975: Evidence of meteorite impact in the Siljan structure, central Sweden. *Bull. Geol. Inst. Univ. Upps., N. S. 6.* Uppsala.

Printed by Ekenäs Tryckeri Ab, Ekenäs, Finland September, 1977.