Ms. rec. May 1st, 1945.

BAVENO-PERICLINE-ALBITE COMBINATION TWINS IN „BIG-FELDSPAR BASALT", HORTEN, THE OSLO REGION

BY

CHRISTOFFER OFTEDAHL

With 2 figures.

Last summer I tried to find the contact between the bottom layer of the Permian effusives and the underlying Permian sediments on the island Løvøya, 4 km NNW of Horten, but did not succeed in finding the contact in solid rock. In the little bay on the west side of the island the contact was covered by talus, but among the great blocks on the shore I found one that seemed to represent the bottom layer of the basaltic lava series (E_1 on the geological maps). One side of this block consisted of a flake of light red sandstone, $(2 \times 2 \times 0.2)$ m^3 in size, and the sandstone contained traces of Permian plant fossils. The sandstone may of course originate from layers of sandstone, deposited between the lava benches, but this is not probable, because the top of the sediments, although obscured, existed in the height just above the block. The lava of the block, bordering to the flake of sandstone, was black, rotten, and full of cavities, containing quartz, calcite, and epidote. About 1 m above the sandstone the lava began to carry feldspar phenocrysts, and 2—3 m above the border the phenocrysts became extraordinarily large. The largest cystals formed plates, $(4 \times 4 \times 0.5)$ cm^3 in size, with (010) as the larger crystal face. Other crystals were smaller and not so flattened, and they occasionally formed prisms, square in cross section. Such a crystal will be described in detail later.

Among the rhomb porphyries one may find lavas with phenocrysts as large as those in the mentioned "big-feldspar basalt", and one lava which is only known from inclusions in breccias in and NW of the Bærum caldron, contains phenocrysts attaining a size of 2.5×6 cm.[1] But among the basalts no previously known lava contains so

[1] O. Holtedahl; Studies on the igneous rock complex of the Oslo region I. Vid.-Akad. Skrifter. I. No. 2. 1943, p. 42.

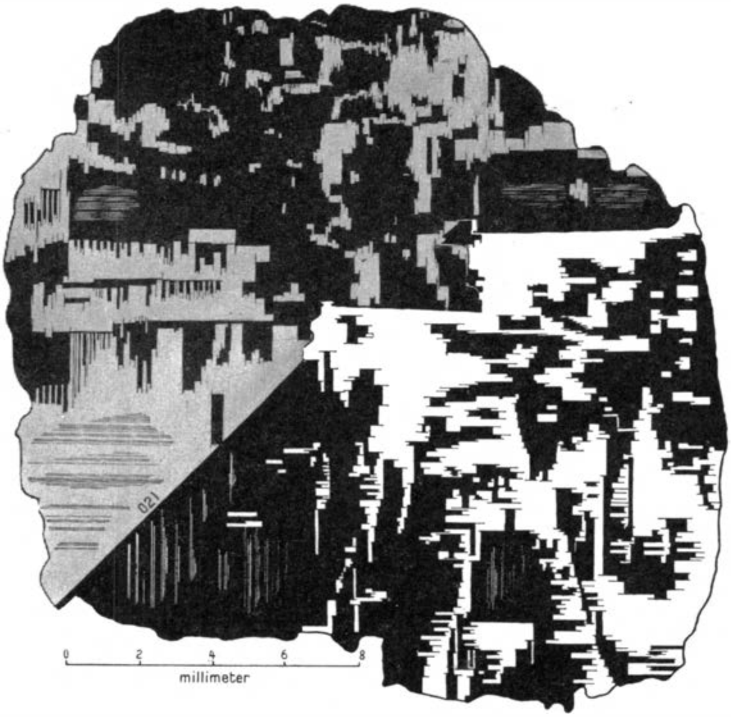

Fig. 1.

large crystals as in the lava block found on Løvøya. Therefore this type is unique among the basalts of the Oslo region, and it may be compared with the "big-feldspar basalt" of Mull, Scotland.[1] In the Scottish lava the sizes of the phenocrysts are about 2.5 cm, but may occasionally increase to 25 cm.

There are two special features of interest as to the Løvøya basalt: It is situated in the bottom layer of the effusives, and its large phenocrysts are locally developed. These features suggest that it represents a limited part of the upper layer of the magma chamber, where the crystallization has proceeded farther than in the deeper and hoter part of the magma.

A thin section shows that the groundmass of the Løvøya basalt is quite ordinary. It consists of iron ore and plagioclase laths, 0.1 mm in length, some chlorite, and small apatite crystals. Scattered augite

[1] E. B. Bailey etc.; Tertiary and post-tertiary geology of Mull, Loch Aline, and Oban. Mem. Geol. Surv. Scotland 1924, p. 146.

crystals, up to 3 cm in length, are observed. The bounding faces of the plagioclase phenocrysts are (010), (001), ($\bar{2}$01), (110), and possibly ($\bar{1}$01). A short prismatic crystal, $(2 \times 2 \times 4)$ cm^3, has been investigated in detail. It is elongated parallel to *a*, and a thin section $\perp$ *a* shows that the crystal is a combination of twins according to the Baveno, pericline, and albite laws. The crystal is not zonar by composition, but a zonar enrichment of iron ore dust is observed. The extinction angle $\perp$ *a* is 32—33°, corresponding to 60—62 An. The refractive indices determined on powder by immersion liquids, however, correspond to a composition of 47—48 An.

Fig. 1 shows a drawing of the section $\perp$ *a* of the interesting twin combination. The two Baveno individuals may be called B_1 and B_2. Each of the two have the pericline twins P_1 and P_2. Hereby the combination B_1P_1, B_1P_2, B_2P_1, and B_2P_2 are produced. They are placed together in the following table:

	1. Bav. individ.	2. Bav. individ.
Black	B_1P_1	B_2P_1
Light	B_1P_2	B_2P_2

Theoretically the albite twins double the number, but they occur only sporadically as thin lamellæ and need not be considered.

The angle between (001) and (021) is nearly 45°, and since the angle between (001) and (010) is nearly 90°, the individuals B_1P_1—B_2P_1 and B_1P_2—B_2P_2 extinguish in pairs. The pericline and albite twins also extinguish contemporaneously, since the angle b: $\perp$ (010) is only 4°. In a certain position therefore the section looks as in Fig. 1; when the microscope stage is rotated a certain angle, the light individuals of Fig. 1 become black.

The Baveno twinning may occur as fourlings, in that both (021) and (0$\bar{2}$1) are twinning planes and composition faces. The combination twinning of Fig. 1 is a sort of a fourling in which only one of the composition faces is developed. In the lower left of the drawing the Baveno trace (021) runs straight-lined and separates the two individuals B_1P_1 and B_2P_2 (black-light). In the upper right half, where the border between the two Baveno individuals runs between B_1P_2 and B_2P_2 (light-light) or B_1P_2 and B_2P_1 (light-black), the composi-

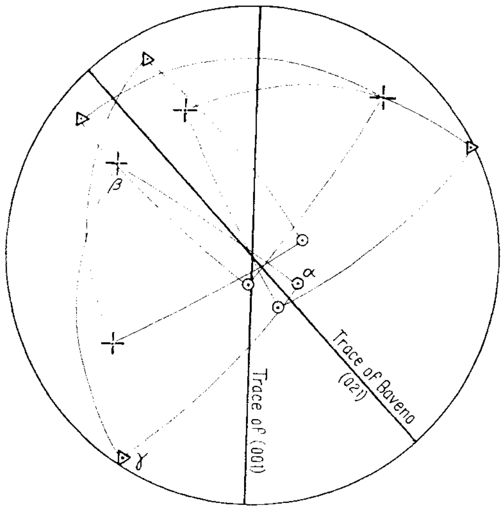

Fig. 2.

tion face $(0\bar{2}1)$ is not developed, but a stereogram shows that B_1P_2—B_2P_1 have (021) as twinning plane. In the middle of the upper right half where the border over a small distance is formed by B_1P_1—B_2P_2, it runs after (021).

The shift of twinning plane may also be seen from Fig. 2, a stereogram from the lower left of Fig. 1. The indicatrix axes α, β, and γ and the traces of (001) and (021) of the individual B_1P_1 are marked. By rotating the diagram around the Baveno trace a second individual (the Baveno twin to the first one) is obtained in the normal orientation. By rotating around an axis $\perp$ [010] a third individual (the pericline twin to the first one) is brought in the position of the first individual. By rotating around the trace (021), which is the trace $(0\bar{2}1)$ of the third individual, it becomes evident that the fourth individual is a Baveno twin to the third.

According to the textbooks of mineralogy the Baveno twinning is "not rare", and it occasionally occurs as a combination twinning, e. g. Baveno—Carlsbad. A Baveno tripple twinning, as described, would seem rather rare, and particularly so in the Oslo region, where other twinning laws than albite, Carlsbad, and pericline are rare.

In Fig. 2 α, β, and γ fall somewhat outside the migration curves of Duparc and Reinhard.[1] The plagioclase belong to the high tem-

[1] Mem. Soc. Phys. Hist. Nat. Geneve, XL, 1924.

perature series,[1] and this also explains the disagreement between the An values when determined by maximum extinction angles and by immersion liquids. The high temperature optics of the feldspars of akerite porphyries and rhomb porphyries have earlier been preliminarily treated by me[2]; the optics of the Oslo Feldspars will be considered in a later paper.

[1] A. Köhler; Min. Petr. Mitt., *53*, 1942, pp. 24—49.
[2] Chr. Oftedahl, Norsk Geol. Tidsskr., *24*, 1944, pp. 75—78.

Mineralogisk Institutt, Oslo, May 1st. 1945.