Zeitschrift: Schweizerische mineralogische und petrographische Mitteilungen = Bulletin suisse de minéralogie et pétrographie

Band: 45 (1965)

Heft: 1

Artikel: Variations in X-ray powder patterns of low structural state plagioclases

Autor: Bambauer, H.U. / Corlett, M. / Eberhard, E.

DOI: https://doi.org/10.5169/seals-35198

Variations in X-ray Powder Patterns of Low Structural State Plagioclases

By *H. U. Bambauer*, *M. Corlett*, *E. Eberhard*, *R. Gubser*, *F. Laves*, *H. U. Nissen* and *K. Viswanathan* *)

With 2 figures in the text

To improve the knowledge of low structural state plagioclases [1]) about 200 specimens from 140 different localities have been investigated with respect to chemical composition, X-ray behaviour, microscopical and submicroscopical characteristics.

The following methods were used: light microscopy, X-ray diffraction (powder photographs with a high-resolution Guinier camera; single crystal photographs with the Buerger precession camera), electron microprobe analysis in all cases (determination of Ca and K in all specimens, of Na in most), wet chemical analysis in many cases and electron microscopy (replica and transmission techniques).

Whereas it is planned to give details in separate papers, some of the main results are presented here in a condensed form.

I. On the basis of their powder patterns the majority of the specimens selected are in or approach the low structural state. It was found that essentially all the specimens are micro- and/or crypto-antiperthitic. The bulk K content of the morphological units lies between Or_0 and Or_4 rarely Or_8). The K content of the plagioclase matrix varies from Or_0 to Or_4 (rarely Or_5); it is usually less than $Or_{0,5}$. When Or contents are given in the following the matrix Or content is meant. It is striking that

*) Institut für Kristallographie und Petrographie, Eidgenössische Technische Hochschule, Zürich, Switzerland.

[1]) By "low structural state plagioclases" is meant the series from albite (low) to anorthite, which is thought to have the highest Al, Si order possible in natural plagioclases.

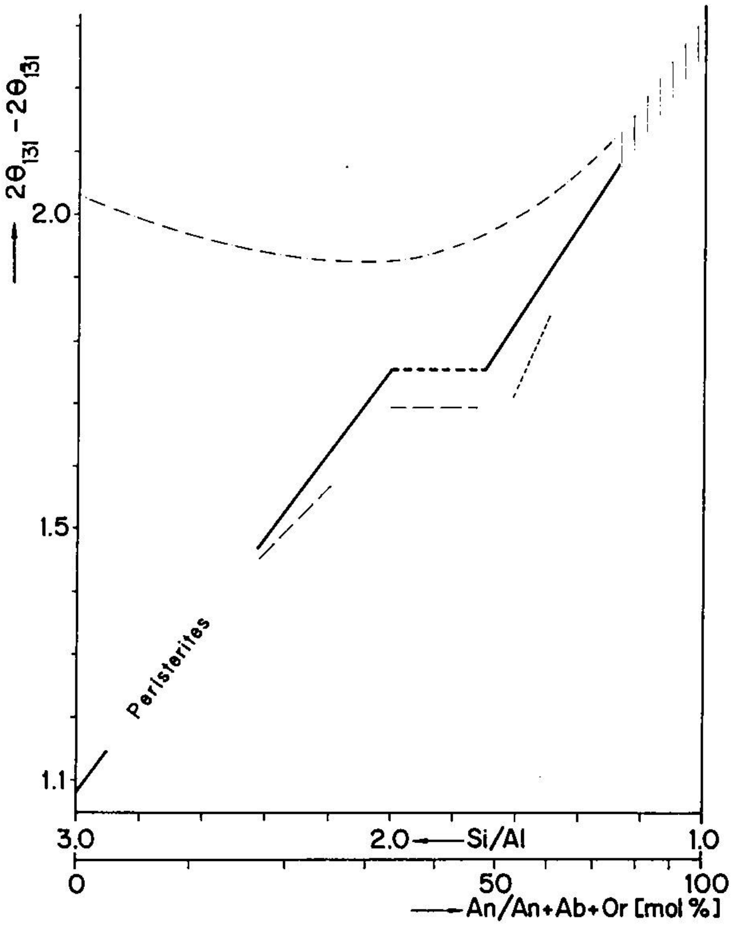

Fig. 1. The relation between 2θ (131)—2θ (1$\bar{3}$1) (CuK_{α_1} radiation) and chemical composition of plagioclases. —·—·—·— : high structural state plagioclases (taken from Smith and Yoder, 1956); ————— : the low structural state boundary curves for plagioclases containing < 0.5 mol% Or. — — — : position of the boundary curve for 4 mol% Or; ------ : position of the boundary curve for 3 mol% Or. A gap has been left in the peristerite region (see text). |||| : see text.

for low structural state plagioclases the higher K contents (> 0.5 mol% Or) occur only in chemically intermediate specimens. With the methods used (in this survey a microprobe beam of 10 μ diameter was chosen) it was impossible to differentiate between isomorphic K distribution in the matrix and "quasihomogeneous" regular fluctuations in the K content (cf. Laves, 1952) approaching an antiperthitic exsolution.

II. Fig. 1 shows the relation between the chemical composition and the values of 2θ (131)—2θ (1$\bar{3}$1) in the powder pattern. The diagram differs somewhat from previous ones (J. V. Smith, 1956; J. R. Smith and Yoder, 1956; Slemmons, 1962):

1. The Si/Al ratio is taken as abscissa (cf. Brown, 1960) instead of the An/An + Ab(+ Or) ratio.

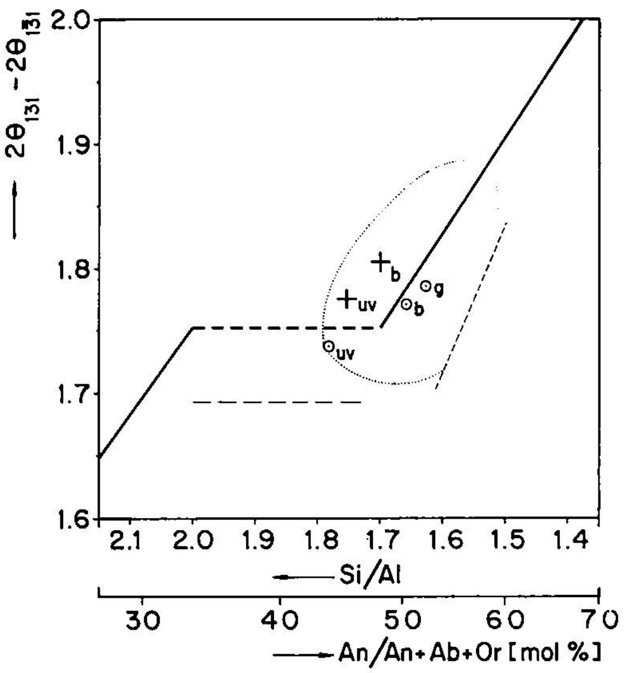

Fig. 2. An enlarged portion of Fig. 1. The dotted oval encloses 28 values obtained for schillering "labradorites"; note that it extends below the petrological definition of labradorite (An_{50-70}). In addition the values from two morphological units are shown; they illustrate the relation between An content and the main schiller colour. uv: ultra-violet; b: blue; g: green.

2. The boundary curves[2]) for low structural state plagioclases with $Or < 0.5$ mol% approximate to straight lines in the following regions:

a) Si/Al = 3.0—2.0 (An_{0-33}), interrupted by the peristerite gap (An_{4-17}).

b) Si/Al = 1,7 to at least 1.25 (An_{48-77}). [The relations from An_{75-100} need further investigation in the light of the special transformation in this region (Brown, Hoffmann and Laves, 1963).]

c) Si/Al = 2.0—1.7 (An_{33-48}). On the basis of the material on hand the boundary curve in this region was found to be horizontal.

3. In Fig. 1 boundary curves (light dashed lines) are also drawn for 3 (and 4) mol% Or; the positions of these curves have been derived from measured and calculated (assuming Vegard's law to be applicable) data. Thus, it is apparent that the Or content of a plagioclase, as well as the An content, must be known in order to draw conclusions on the structural state from the difference 2θ (131)—2θ ($1\bar{3}1$).

4. An unambiguous identification of the 131 and $1\bar{3}1$ lines belonging to the two components of peristerites was often difficult and sometimes

---

[2]) Above the curves values were found, below the curves not.

impossible. Therefore the corresponding points were not used in the construction of Fig. 1. In this connection it may be mentioned that electron transmission and replica investigations have shown that peristerites are built up of lamellar discontinuities similar to those of "labradorites" with schiller (see point III).

III. In Fig. 2 the field of chemically intermediate plagioclases with schiller (schillering "labradorites") is depicted on the basis of the specimens on hand. The specimens have a rather high K content. In addition special values are inserted which were measured on different zones of morphological units which differ in their schiller colour. As a general trend it can be said that anincreasing An content favours an increasing "average wavelength" of the reflected light (ultra-violet, blue, green, yellow, orange, red). The "ultra-violet schiller" could be detected by an ultra-violet spectrophotometer. In the electron microscope all plagioclases with schiller revealed patterns of lamellar discontinuities, first observed by BAIER and PENSE (1957). They have been interpreted as an alternation of lamellar domains of differing plagioclase material by LAVES, NISSEN and BOLLMANN (1965).

Acknowledgements: Our thanks to G. O. Brunner for permission to use his spectrophotometric measurements in the ultra-violet and visible regions, and to P. Thommen and Prof. M. Weibel for providing the wet chemical analyses. Thanks are due to the "Schweizerische Nationalfonds zur Förderung der wissenschaftlichen Forschung".

References

BAIER, E. and PENSE, J. (1957): Elektronenmikroskopische Untersuchungen an Labradoren. Naturwiss. *44*, p. 110—111.

BROWN, W. L. (1960): Lattice changes in heat treated plagioclases. Z. Krist. *113*, p. 297—329.

BROWN, W. L., HOFFMANN, W. and LAVES, F. (1963): Über kontinuierliche und reversible Transformationen des Anorthits. Naturwiss. *6*, p. 221.

LAVES, F. (1952): Phase relations of the alkali feldspars, II. J. Geol. *60*, p. 549—574.

LAVES, F., NISSEN, H. U. and BOLLMANN, W. (1965): On schiller and submicroscopical lamellae of labradorite. Naturwiss., in press.

SLEMMONS, D. B. (1962): Observation on order-disorder relations of natural plagioclase. I. A method of evaluating order-disorder. Norsk. Geol. Tidskr. *42*, 2; p. 533—554.

SMITH, J. V. (1956): The powder patterns and lattice parameters of plagioclase feldpars. I. The soda-rich plagioclases. Min. Mag. *31*, p. 47—68.

SMITH, J. R. and YODER, H. S. (1956): Variations in x-ray powder diffraction patterns of plagioclase feldspars. Am. Min. *41*, p. 632—647.

Manuscript received May 4, 1965.