Citation:

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eology. — *"On zonal amphiboles, in which the plane of optic axes of the margin is normal to that of the central part".* By H. A. BROUWER. (Communicated by Prof. G. A. F. MOLENGRAAFF).

(Communicated in the meeting of February 22, 1913).

Especially in rocks, which are rich in alcalies various rare nphiboles with peculiar optical properties have been described from fferent localities. Their chemical and optical properties have not et been sufficiently determined for their classification.

In dynamometamorphic basic eruptive rocks from the island of Leti, hich have been collected during Prof. Dr. G. A. F. MOLENGRAAFF's imor-Expedition, intergrowths of different amphiboles occur; of iese intergrowths zonal crystals, which partly consist of actinolite r common hornblende and partly of crossitic amphiboles [1]), in which ie plane of optic axes is normal to the plane of symmetry, are specially interesting. In connection with these intergrowths of amphibo-s, which are chiefly formed in metamorphic rocks, other zonal crystals f pyrogenetic amphiboles, which occur in aegirineamphibolefoyaites om Zandriviersspoort (332), in the southwestern part of the Pilands-erg-complex (Transvaal), will be mentioned. In the central part f the latter amphiboles, the plane of the optic axes lies in the lane of symmetry, in the marginal part it is normal to the plane f symmetry. Where amphiboles with the plane of optic axes erpendicular to the plane of symmetry have been mentioned from ther localities, their intergrowth with the normal amphiboles is lso a common phenomenon.

1. *Zonal amphiboles from the island of Leti.*

In a diabasic rock from a conglomerate near the well Prigi Tiga, ı which the augite has been partly converted into amphiboles, the rossite occurs in numerous crystals, which often show a zonal ructure with different extinction angles for the central and marginal arts. Many crystals of crossite are surrounded by a narrow marginal one of actinolite and zonal amphiboles with a central part of common

[1]) Crossite, according to ROSENBUSCH (Mikrosk. Physiographie, I. 2, p. 246), id not the amphibole with the plane of optical axes in the plane of symmetry hich originally has been described by PALACHE (comp. Univ. of California, Bull. ep. of Geology 1894, p. 181).

The crossite in rocks from the island of Leti has already been mentioned by ERBEEK (comp. Molukken Verslag, Jaarb. v. h. Mijnwezen, Wetensch. Ged. p. 591) cording to the determination of GRUTTERINK.

hornblende and a margin of a crossitic amphibole, are found in small qnantities in the rock.

Intergrowths of crossite and actinolite have been described from other localities, those of crossite and common hornblende will be described more in detail.

In a section, the crossitic amphibole of which showed a strong pleochroism from blue to nearly colourless, the central part was pleochroic from light brownish yellow to darker brownish yellow; in the marginal zone the crossite showed an extinction angle of 14°, which towards the centre gradually decreased to 9°, whilst in the common hornblende this angle gradually increased to 17°. In both amphiboles the prism axis is parallel to the slow ray.

In a section, the crossitic amphibole of which was pleochroic from slightly bluish violet to blue, the central part showed the darker brownish yellow colour and was only very little pleochroic.

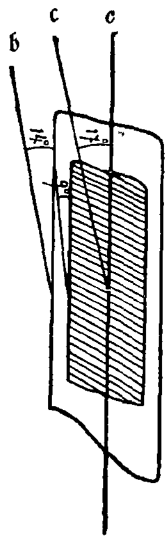


Fig. 1.
Intergrowth of crossitic and brownish yellow amphibole. Section ± parallel to (010); ×200.

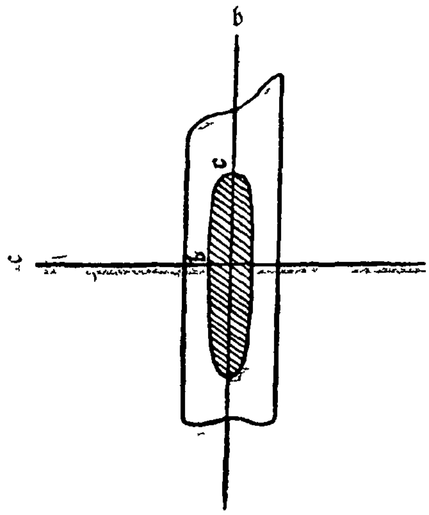


Fig. 2.
Id. Section ± parallel to (100); ×200.

In this section the prism axis of the marginal zone was parallel to the fast ray, whilst that of the central zone was parallel to the slow ray. In the section small oblique extinctions were seen, so that it was not exactly perpendicular to the plane of symmetry.

The pleochroism for the central and marginal amphiboles is as llows:

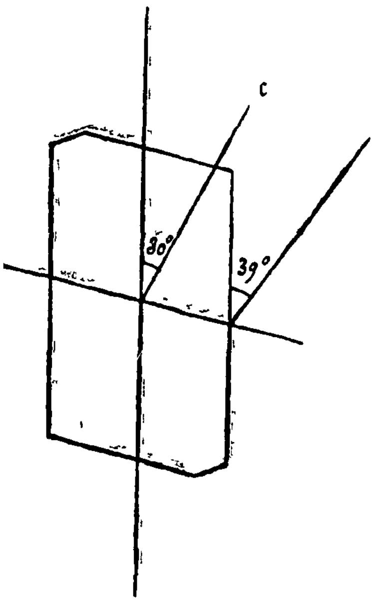
Centre.	*Margin.*
$\mathfrak{c}$ brownish yellow	$\mathfrak{c}$ slightly bluish violet
$\mathfrak{b}$ brownish yellow	$\mathfrak{b}$ blue
$\mathfrak{a}$ light yellow	$\mathfrak{a}$ nearly colourless.

It is evident that the crystallographic axes of both amphiboles incide, whilst the plane of optic axes of the central amphibole s in the plane of symmetry and that of the marginal one is rpendicular to the plane of symmetry. The angle $\mathfrak{b} : c$ is smaller an that of the typical crossites, whilst only in some of the zonal ystals of crossite, this angle increases to 30°.

The limit between the different amphiboles in the zonal crystals rather irregular and there is only a narrow zone of transition tween them.

2. *Zonal amphiboles from the Pilandsbergen.*

In aegirineamphibolefoyaites, which have been collected on Zand-ierspoort (332) to the South-West of the Pilandsberg complex, crystals of zonal amphiboles which are tabular on the clinopinacoid, occur. In a section, which was nearly parallel to (010) the central part had a brownish colour, whilst in the marginal zone the colour was more greenish and darker, to darkgreen. The angle between the c-axis and the axis of smallest absorption was 30° for the central and 39° for the marginal zone; these angles and the colours of the central and the marginal zone are not the same in different crystals, but the brownish colours are always found in the central and the greenish colours in the marginal zone.



. 3. Amphibole of Zandrivierspoort 332). Section ± parallel to (010).

Sections, in which both central l marginal part are nearly perpendicular to the negative bisectrix w that the angle of optic axes is small for the central part and her large for the marginal one. The plane of optic axes is perpendicular to the plane of symmetry in the marginal zone. These amphiboles resemble those in the shonkinite of the Katzenbuckel (Odenwald) [1].

The relation between these peculiar amphiboles and the normal types can be seen from the study of the zonal crystals in which these peculiar amphiboles are found together with the normal types. With regard to the common hornblendes, the basaltic ones are characterized by smaller extinctionangles and smaller angles of optic axes, their alkali- and high ironcontent.

Similar differences seem to exist between the amphiboles in the zonal crystals with crossite, in which the extinctionangles decrease from 17° to 9° in the brown amphibole. After the turning of the plane of optical axes the margin consists of a crossitic amphibole which is rich in iron and alkalies. In the zonal crystals with crossite and actinolite, the content of sesquioxydes and alkalies strongly increases from the margin to the centre, the turning of the plane of optic axes takes place in a zone of transitional chemical composition. Other amphiboles, which are connected by transitions with the common hornblendes are especially found in igneous rocks rich in alkalies, they are characterized by a larger angle $c:\mathfrak{c}$ and a smaller axial angle, and are chemically characterized by a high content of iron and alkalics. However their optical and chemical properties are not known in detail. From the description of the zonal crystals of the Pilandsbergen and those of the Katzenbuckel, it is evident, that the turning of the plane of optic axes can result from a small change in the chemical composition of such amphiboles, whilst in other cases (Katoforites) the plane of optic axes remains in the plane of symmetry, whilst the angle $c:\mathfrak{c}$ can increase from 30° to 60° and so passes into that of the arfvedsonites.

The anoforites from the Katzenbuckel in which the plane of the optic axes is normal to the plane of symmetry (comp. Neues Jahrbuch f. Min. 1910. 1. p. 34), and which in zonal crystals are connected with katoforitic amphiboles, differ chemically from the Katoforites by a lower FeO- and a higher MgO content. The extinctionangles are 20—27° in the acute angle β. There are amphiboles without the large angle $c:\mathfrak{c}$, in which the turning of the plane of the optic axes may be expected in zonal crystals. This is probable for certain amphiboles from pegmatitic segregations in the aegirine-amphibolefoyaites from Buffelspan (585). Their plane of the optic axes was normal to the plane of symmetry, the angle $\mathfrak{b}:c = 14°$

[1]) W FREUDENBERG. Geologie und Petrographie des Katzenbuckels im Odenwald. Mitt. der Groszh. Badischen Geol. Landesanstalt. Band V. 1906.

d $c = b$. Their angle $2V$ is small or very small, sometimes these ıphiboles are nearly uniaxial and are connected with the distinctly ıxial ones in zonal crystals.

These amphiboles sometimes are intergrown with biotite or aegi-ıe and also with a bluish green amphibole, in which the plane of tic axes is also normal to the plane of symmetry, if they have ; same crystallographic orientation as the brownish green amphi-les. In sections parallel to (100) of the latter ones, the prism axis parallel to the fast ray in the bluish green amphiboles, whilst in :tions parallel to (010) it is nearly parallel to the slow ray.

From the facts, which have been mentioned above, it is evident, ıt amphiboles, in which the plane of optic axes lies in the plane symmetry, very probably occur at the same locality.

ıtronomy. — *"On canonical elements."* By Prof. W. DE SITTER.

In the developments of the planetary theory each of the three omalies has been used as independent variable: the mean anomaly LAGRANGE, the excentric anomaly by HANSEN and the true anomaly GYLDÉN. All systems of canonical elements, however, which have en in use up to the present time, are only modifications of the ;tem of DELAUNAY, which is based on the use of the *mean* anomaly. Recently [1]) LEVI-CIVITA has proposed a new system of elements, in ıich the *excentric* anomaly appears instead of the mean anomaly; most simultaneously [2]) HILL has called attention to another system which the *true* anomaly appears as one of the variables. The ;thod by which HILL arrived at his system is, however, very ferent from that by which the systems of DELAUNAY and LEVI-CIVITA ; developed. The object of the present paper is to show how these :ee systems, as well as others, can be derived from the same ndamental principle.

Let x_i be the co-ordinates of a body P, and $y_i = m\dfrac{dx_i}{dt}$ the com-nents of its momentum ($i = 1, 2, 3$). The equations of motion ; then

$$\frac{dx_i}{dt} = \frac{\partial H}{\partial y_i}\ , \quad \frac{dy_i}{dt} = -\frac{\partial H}{\partial x_i}\ , \qquad \ldots \ldots \ldots \quad (1)$$

·) T. LEVI-CIVITA. Nuovo sistema canonico di elementi ellittici. Annali di Mate-tica, Ser. III, Tom. XX, p. 153 (Aprile 1913).

') G. W. HILL. Motion of a system of material points under the action of avitation. Astronomical Journal, Vol. XXVII, Nr. 646—647, p. 171 (1913 April 28).