Sci. Annals, Fac. Phys. & Mathem., Univ. Thessaloniki, 16, 219 (1976)

CONTRIBUTION TO THE STUDY OF AUTHIGENIC ALBITES OF SOME DISTRICTS IN CRETE.

by

K. SOLDATOS AND A. KASSOLI

(Department of Mineralogy and Petrography Aristotelian University of Thessaloniki)

(Received 20.8.1976)

Abstract: *In the present paper anthigenic albite crystals are examined by X-ray investigation. The above crystals were found in dolomitic limestones of certain districts in Crete. After a short optical description the main constants of the cell are given. The projections of α* and γ* in three diagrams of plagioclases, taken from bibliography, follow from which the nature of the albites as low-albites (of low temperature) results. Finally a report is given and the found elements are compared to the data of bibliography including also the origin of the albites.*

This paper is mainly dealing with the X-ray investigation of certain authigenic albite crystals which appear in gray dolomitic limestones of Crete. The above albites were optically studied by Papastamatiou, (1955) and were previously described by Cayeux, (1903). Besides, some observations on two albite crystals from the Cretan localities Liopetro and Ravdoukha are mentioned by Kastner and Waldbaum, (1968) in their paper «Authigenic Albite from Rhodes».

The specimens we studied were collected from the areas Profitis Ilias of Sitia, Stomion of Western Crete, Sellia of Rethimno of Central Crete and from a locality on the west of mount Vornakas 1600 m height. All the specimens except that from Vornakas were kindly provided by Professor J. Papastamatiou, Athens. That from Vornakas was offered by Professor L. Sotiriadis, Thessaloniki. To both we express our thanks.

The examined albites, having a size usually ranging up to 2 mm, are euhedral, tabular on (010) and they are of black color macroscopically with a characteristic luster of the crystal faces (010). In thin sections they appear colorless, transparent with clear cleavage (001) on the face (010).

The crystals often contain carbonate inclusions of the same composition with the matrix as well as opaque carbonaceous inclusions which appear as black dots. These inclusions sometimes are irregularly distributed but mostly they are arranged in the center of the crystal parallel to the growth faces so as the outer portions of the crystal appear clearer (Fig. 1). The remarks of Kastner and Waldbaum (1968) that the inclusions are usually found in the outer parts of the crystals were not in agreement with our observations. On the contrary the most times the opposite was noticed.

Calcite veinlets often cross the albite crystals and discolor them so as we observe quite often the phenomenon of crystals having two colors, that is partly white and partly black (Fig. 2). Besides many times the albite crystals are interrupted by veinlets which often are continued in the host rock. These veinlets having derived secondarily from circulated solutions are consisted of calcite and quartz. Not rarely there was observed a partial or complete substitution of albite by calcite and quartz either independently or by both.

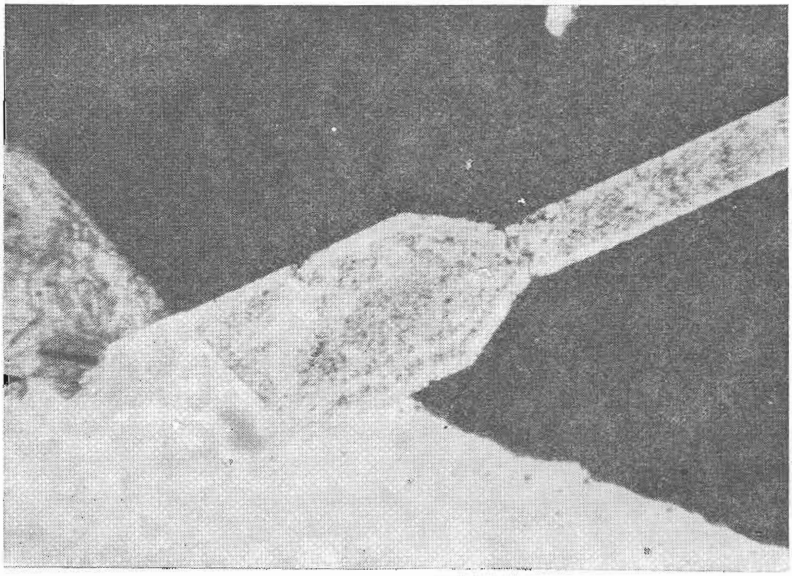

Fig. 1. Photomicrograph of albite crystal being crossed by a calcite vein. Inclusions arranged in the center parallel to the growth faces. Uncrossed polars. M10X.

Generally the crystals of the examined albites do not have a certain arrangement in the dolomite but they are irregularly distributed.

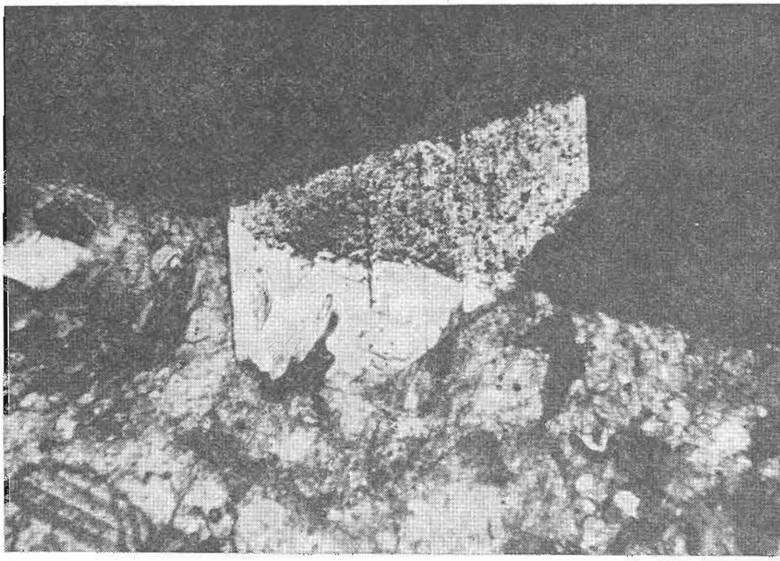

Fig. 2. Photomicrograph of albite crystal crossed and partly discolored by a calcite vein. Crossed polars. M10X.

Examination by means of the Universal Stage and using the Rittmann methods as well as the V.d. Kaaden diagrams showed that the Anorthite content ranges between 2-7% with the maximum frequency at 4-5% An. The optic axial angle was found $2V\gamma = 78^o$-80^o and the occurring twins after the Carlsbad aud the Albite laws. Penetration twins are also quite often. The above optical data are in agreement generally with the observations of Papastamatiou (1954) so we didn't prolong in details here about this field. The extinction angle to n'_α in section normal to a ranges between 13^o-17^o.

The albite crystals were examined by means of X-rays, mainly using the Precession method (Buerger). For the examination of the albites with the above method, albite crystals were cautiously separated from thin sections under the microscope. Orientated sections with respect to the optic or crystallographic elements were mostly prefered. The b* axis of the reciprocal lattice was placed always parallel to the spindle axis during examination. This had as a result the estimation of the angle β from the rotation on the spindle axis since it coincides with the difference between the two readings which correspond to the Pa and Pc directions 0-level, that is a corresponding of the directed radiation in parallel with the [100] and [001] directions. Though the values of angle β are of little importance in feldspar studies (Smith, 1974) because of their sensitivity towards many factors, even towards least differences in the chemical composition, however, efforts there were made to avoid as much as possible the reading errors. This, as it is known, is better accomplished when the above way of work is applied by using the two corresponding orientation films with respect to Pa and Pc directions.

The used equations for the calculation of the various constants were;

$$d = \frac{\lambda}{d^*} \qquad d^* = \frac{M}{F} \qquad a_o^* = \frac{1}{d(100)} \qquad b_o^* = \frac{1}{d(010)} \qquad c_o^* = \frac{1}{d(001)}$$

$$V^* = a_o^* b_o^* c_o^* \sin \alpha^* \sin\beta \sin\gamma^*$$

$$V = \frac{1}{V^*} \qquad a_o = \frac{b_o^* c_o^* \sin\alpha^*}{V^*} \qquad b_o = \frac{c_o^* a_o^* \sin\beta^*}{V^*} \qquad c_o = \frac{a_o^* b_o^* \sin\gamma^*}{V^*}$$

$$\cos\beta = \frac{\cos\alpha^* \cos\gamma^* - \cos\beta^*}{\sin\alpha^* \sin\gamma^*}$$

M = distance between corresponding reflections

Fifteen crystals separated from more were studied. Unfortunately from the above fiffteen only five gave suitable elements which are published. The rest from the X-ray studied showed quite often diffuse radiations probably because of mosaic structure.

In the following Table 1 of page 5 there are given the values of the measured constants of the cell.

With respect to the values of Table 1 there are given below the projections of the examined crystals in three diagrams taken from the literature. It is obvious that the above albites are projected in all the diagrams in the area of Low-Albite.

In contrast to the high-temperature plagioclases the natural low-temperature plagioclases show large changes in the lattice parameters. From An_0 to An_{50} the changes are as follows: α_o^* -1/150, b_o^* -1/150, c_o^* + 1/200, α^* -0.3°, β^* + 0.2°, γ^* -1.8° (Smith, 1956). The largest change is in γ^*, and this is tbe basis of all methods proposed for the determination of composition of soda-rich plagioclases from powder records. It is interesting to note that all the high - temperature pla-

TABLE I

Constants / Disrticts	$d_{(010)}$	$d_{(001)}$	$d_{(100}$	a_o^*	b_o^*	c_o^*	a_o	b_o	c_o	a^*	γ^*	β	V^*	V
Ab_7 Profitis Ilias	12.730	6.381	7.270	0.1375	0.0785	0.1567	8.0942	12.7533	7.1186	86°28′	90°25′	116°5′	0.00152	658.8
Ab_6 Profitis Ilias	12.722	6.381	7.270	0.1375	0.0786	0.1567	8.1083	12.7200	7.1286	86°30′	90°25′	116°15′	0.00152	659.6
Ab_3 Profitis Ilias	12.724	6.379	7.274	0.1375	0.0786	0.1568	8.1593	12.8592	7.1478	86°30′	90°26′	116°33′	0.00150	668.8
Ab_{10} Sellia	12.721	6.374	7.270	0.1375	0.0786	0.1570	8.0929	12.7562	7.1064	86°26′	90°28′	116°18′	0.00152	657.4
Ab_8 Vornakas	12.723	6.381	7.273	0.1375	0.0786	0.1567	8.1435	12.7843	7.1590	86°30′	90°25′	116°43′	0.00151	662.6

Values of a_0, h_0, c_0 and $d_{(010)}$, $d_{(001)}$, $d_{(100)}$ in Å. The limit of error is usually ± 0.002 Å. a_0^*, b_o^*, c_o^* reciprocal cell edges in $Å^{-1}$. β:cell angle in degress. a^*, γ^*: reciprocal cell angles in degrees. The limit of error is about 5′. V: volume of the cell calculated from lbe lattice constants. V^*. reciprocal cell volume.

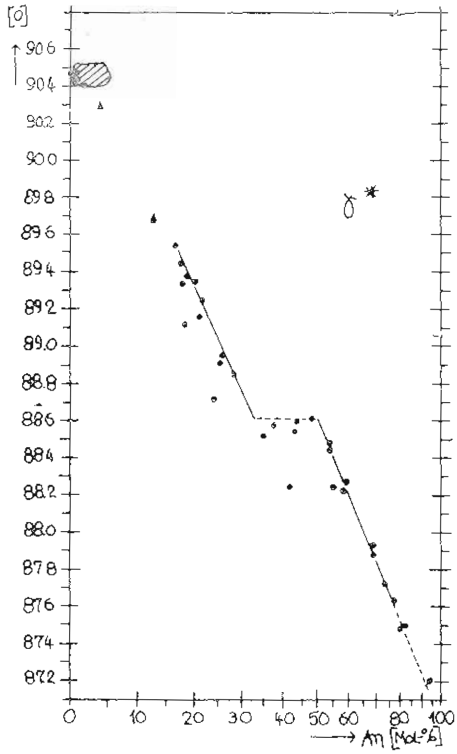

Fig. 3

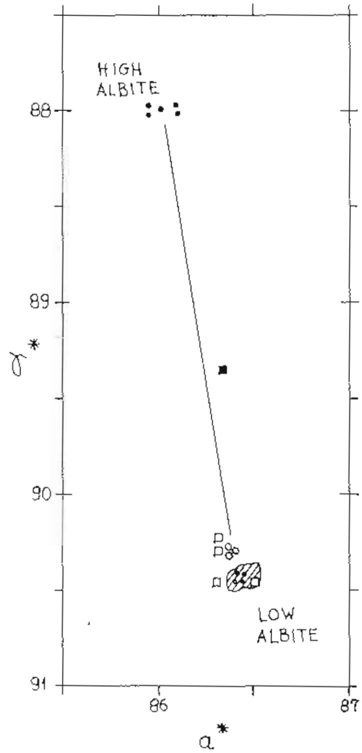

Fig. 4

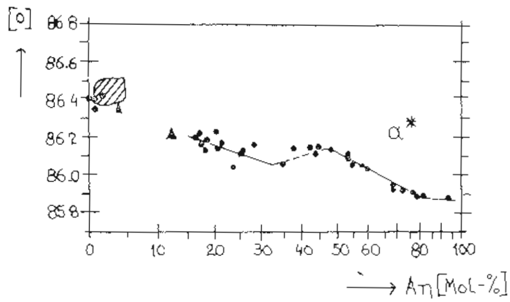

Fig. 5

Figures 3 and 5 are related to corresponding diagrams of Bambauer et al (1967) and Fig. 4 is related to a diagram of Kastner and Waldbaum (1968). The examined specimens fall into the striped regions.

gioclases as well as the low-temperature plagioclases which are more calcic than An_{10} have γ^* acute whereas the low-temperature plagioclases from An_0 to An_{10} have an obtuse value for γ^*.

With respect to the above from all the rest constants the γ^* angle was used as a better criterion of the anorthite content. In Fig. 3. (Bambauer et al, 1967) which gives the change of γ^* as regards the anorthite content, the area where the examined albites fall into is marked. So according to the above mentioned the anorthite content of the examined albite crystals with respect to γ^* is found in very low limits between 3-5% An, which comes in very satisfying agreement with the optical data.

From Fig. 5. analogous conclusions derive (with a little smaller values) but the inclination of the curve is not so characteristic as it is in the diagram of γ^*, that is why, as it was mentioned above, the constant γ^* is used as a better criterion.

In Fig. 4. the projection of the examined albites coincides with the corresponding field of Rhodian albites.

In bibliography (Baskin 1956) it is reported that the cell dimensions of authigenic albites are substantially smaller than those of low albites from other geological environments. Though in general lines the above can be mentioned for the examined albites (from the comparison of constant V to V of Amelia Albite) (Kastner and Waldbaum, 1968), however, we can not entirely adopt the above, because, for the calculations of V the value of β angle is used, the measurement of which is not exceptionally precise.

As regards the optic axial angle Kastner and Waldbaum, (1968) report and agree with Baskin's and Füchtbauer's aspects that authigenic albites have generally higher values. According to them the area of 81°-82° is mentioned. However to Papastamatiou (1955) there are reported relatively lower values 74°-76°. In the present paper the values that were found range between the above in the area of 78°-80°.

As regards the genesis of authigenic albites the following can be mentioned: On the contrary of the most feldspars, which are formed either by metamorphism processes or from the consolidation of magma during of which in most cases high pressures and temperatures dominate, at least being compared with the conditions of a sedimentary formation, authigenic albites are formed «in situ» in sediments under conditions of rather lower pressure and temperature. «It is generally accepted that the formation of feldspars at near-surface conditions requires rather high ratios of alkali ions to hydrogen ions in the liquid phase» (Van Der Plas, 1966). The theory that by leaching of alkali-rich material the ground water can become rich in alkaline and thus promote the growth of such minerals is different than other current ideas in soil science. For the formation of authigenic albite the aspect that it may be promoted by the presence of high concentrations of calcium ions, seems to dominate. That is why authigenic albites are found in such rocks (limestones, dolomites).

Though the genesis of these authigenic formations is not sufficiently studied the following could be considered as possible: Detrital feldspars, just as heavy minerals may function as a characteristic of a sedimentary formation. Hydrothermal or metasomatic fluids are not considered to have taken part in this formation. This is also accepted by Kastner and Waldbaum who consider that Rhodian albites must not have been crystallized at higher temperatures than albites of other geological conditions.

From comparison of the X-ray data with those given by the above authors as well as with the known elements of Amelia Albite, at least as regards those constants which are independent of β augle for which as it was mentioned the measurement errors are greater, there are not significant differences for a disagreement to be established as regards the Al/Si distribution with respect to albites of other genetical origins as for example of pegmatites.

According to some authors (Kastner and Waldbaum 1968) it is considered that the tetrahedral Al/Si distribution of tbe authigenic albites is highly ordered, but not as ordered as low albites from pegmatites. This of course is also based in optical data but as it was mentioned above the present optical elements differ a little from those mentioned by the above authors.

REFERENCES

BAMBAUER H. U., EBERHARD E. and VISWANATHAN K. (1967). The Lattice Constants and Related Parameters of «Plagioclases (low)». Schweiz. Mineralogische und Petrographische Mitteilungen, 47/1, 351-364.

BASKIN, Y. (1956). A study of authigenic feldspars. J. Geol., 64, 132-155.

CAYEUX, M. L. (1903). Sur la presence de cristaux macroscopiques d'albite dans les dolomites du Trias de la Crete. C. R. Acad. Sci. Paris, 136, 1703-1704.

KASTNER M. and WALDBAUM D.R. (1968). Authigenic Albite from Rhodes. Amer. Mineral., 53^2, 1579-1602.

PAPASTAMATIOU, J. N. (1955). Sur la presence et la genese de cristaux d'albite dans quelques roches carbonatées de l'isle de Crete. Delt. Hellenik. Geol. Etair., 2, 87-97.

SMITH J. V. (1956). The Powder Patterns and Lattice Parameters of Plagioclase Felspars. 1. The Soda-Rich Plagioclases. Mineral. Mag. 31, 47-68.

SMITH J. V. (1974). Feldspar Minerals. Volnme 1.

VAN DER PLAS, L. (1966). The Identification of Detrital Feldspars. Elsevier, Amsterdam.

ΠΕΡΙΛΗΨΙΣ

ΣΥΜΒΟΛΗ ΕΙΣ ΤΗΝ ΜΕΛΕΤΗΝ ΑΥΘΙΓΕΝΩΝ ΑΛΒΙΤΩΝ ΠΕΡΙΟΧΩΝ ΤΗΣ ΚΡΗΤΗΣ

Ὑπὸ

Κ. ΣΟΛΔΑΤΟΥ ΚΑΙ Α. ΚΑΣΩΛΗ

(Ἐργαστήριον Ὀρυκτολογίας - Πετρογραφίας)

Εἰς τὴν παροῦσαν μελέτην ἐξετάζονται κυρίως ἀπὸ ἀκτινογραφικῆς πλευρᾶς κρύσταλλοι αὐθιγενῶν ἀλβιτῶν εὑρεθέντες ἐντὸς δολομιτικῶν ἀσβεστολίθων περιοχῶν τῆς Κρήτης.

Μετὰ σύντομον ὀπτικὴν περιγραφὴν δίδονται αἱ κυριώτεραι κρυσταλλογραφικαὶ σταθεραὶ τῆς κυψελίδος. Ἀκολούθως σημειοῦνται αἱ προβολαὶ α* καὶ γ* εἰς τρία διαγράμματα πλαγιοκλάστων ληφθέντων ἐκ τῆς βιβλιογραφίας ἀπὸ τὰ ὁποῖα διαπιστοῦται ἡ φύσις τῶν ἀλβιτῶν ὡς χαμαι-ἀλβιτῶν (χαμηλῆς θερμοκρασίας).

Τέλος γίνεται ἀναφορὰ καὶ σύγκρισις τῶν εὑρεθέντων στοιχείων πρὸς τὰ βιβλιογραφικὰ δεδομένα ἐν συνδυασμῷ πρὸς τὴν προέλευσιν τῶν ἀλβιτῶν.