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SYNNEUSIS OF PLAGIOCLASE WITH K-FELDSPAR IN M.TE CAPANNE (ELBA ISLAND) GRANODIORITE

ABSTRACT. — The optical study of the plagioclases contained in the K-feldspar megacrysts of the M.te Capanne (Elba Island, Italy) granodiorite has shown that 90% of them are three-dimensional oriented against the host K-feldspar. The measured data allow to conclude for a typical synneusis structure between two different minerals.

RIASSUNTO. — Vengono riportati i dati relativi ad uno studio ottico eseguito al T.U. su 286 plagioclasi contenuti in tre cristalli porfirici di feldspato potassico due dei quali provenienti dalla granodiorite del M.te Capanne e uno proveniente da rocce porfiriche dell'Isola d'Elba (Toscana). Di tutti i plagioclasi misurati circa il 90% presenta una orientazione cristallografica con il feldspato potassico che li ospita; tale orientazione è caratterizzata dal parallelismo tra i piani {010} del plagioclasio e i piani {010} o {001} o {110} del feldspato potassico. Nella maggior parte dei casi, quando il parallelismo interessa i piani {010} dei due minerali si osserva anche il parallelismo dei relativi assi cristallografici.

I dati ottenuti permettono di stabilire la presenza di tipiche strutture di sinneusi tra questi due minerali.

K-feldspar megacrysts (Kfm) characterize many porphiritic granitic or granodioritic facies. These megacrysts include the minerals of the groundmass of the host rock, in particular they contain many small oriented laths of plagioclase. The mutual orientations of KFm and included plagioclases has been studied at length by many authors (see for references Frasl, 1954 and Vance, 1969).

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Studying the KFm of the M.te Capanne (Elba Island, Italy) granodiorite we have observed typical synneusis structures between K-feldspar and plagioclases. We report the results of an optical study of these structures.

Experimental procedures.

For this study three KFm thin sections have been selected. The three sections are identified as follows:

A - Granodiorite, peripherical facies. The section has been cut almost perpendicular to (010) of the KFm.
B - Granodiorite peripherical facies. The section has been cut almost parallel to (100) of the KFm.
C - Porphiritic dike. The section has been cut almost parallel to (001) of the KFm.

All the three KFm examined are Karlsbad twins with the two portions of the twin almost equally developed. In every section, and only in one portion of the twin, the orientations of all the included laths of plagioclases have been determined by optical means utilizing an universal stage.

— Albite-Karlsbad twinned plagioclases. In these twins the orientation of the (010) plane and of the [001] and [100] directions has been measured. The measures are referred to that portion of the plagioclase karlsbad twin which is toward the core of the KFm (portion 2 in figure 1).

The [001] direction has been identified measuring the extinction values of the two portions of the Karlsbad twin brought to the equal illumination in the symmetrical zone. The [100] direction has been identified studying the extinction values measured in the symmetrical zone at several distances from the two possible positions ($\lambda = 0$ and $\lambda = 90°$) of the equal illumination of the Karlsbad twin. No effort has been made to determine the orientation of the [010] axis; that is no effort has been made to determine what of the two portion of the albite twin was toward the core of the K-feldspar megacrysts.

— Albite twinned plagioclases. On these twins it would be possible in theory to determine the orientation of the [001] direction constructing the whole extinction curve in the symmetrical zone. However we

have preferred to determine the orientation of the X-axis of the optical indicatrix. The measured plagioclases have in fact a composition in the range An_{25}-An_{35}: the optical indicatrix X-axis is therefore very near to the [100] direction. For these twins obviously it remains an ambiguity for what concern the orientation of the [001] direction.

— Other twinned plagioclases. When it has been possible the crystal-

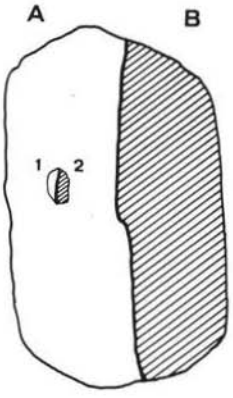

Fig. 1. — A typical K-feldspar megacryst (Karlsbad twinned) and one of the included plagioclases are shown. All the included plagioclases have been measured in the A portion of the K-feldspar twin; the orientation of the Albite-Karlsbad twinned plagioclases is referred to the portion 2.

lographic orientation has been obtained measuring the optical orientations of the two portions of the twin and plotting the data on a Wulff net.

— Not twinned plagioclases. For these plagioclases which are very rare, we have not tried any measures. They are referred to as not determined in the following tables.

Results.

All the measured plagioclases have been plotted on a stereographic net against the orientation of the KFm that contained them. Figure 2 reports all the measures obtained from the three thin sections. The KFm orientation has been normalized to the standard projection with [001] at the center of the net and (010) at the right. Results are more clearly shown in tables 1, 2 and 3.

Table 1 reports the observed orientations of the {010} planes of plagioclases against planes of KFm. For every orientation a distinc-

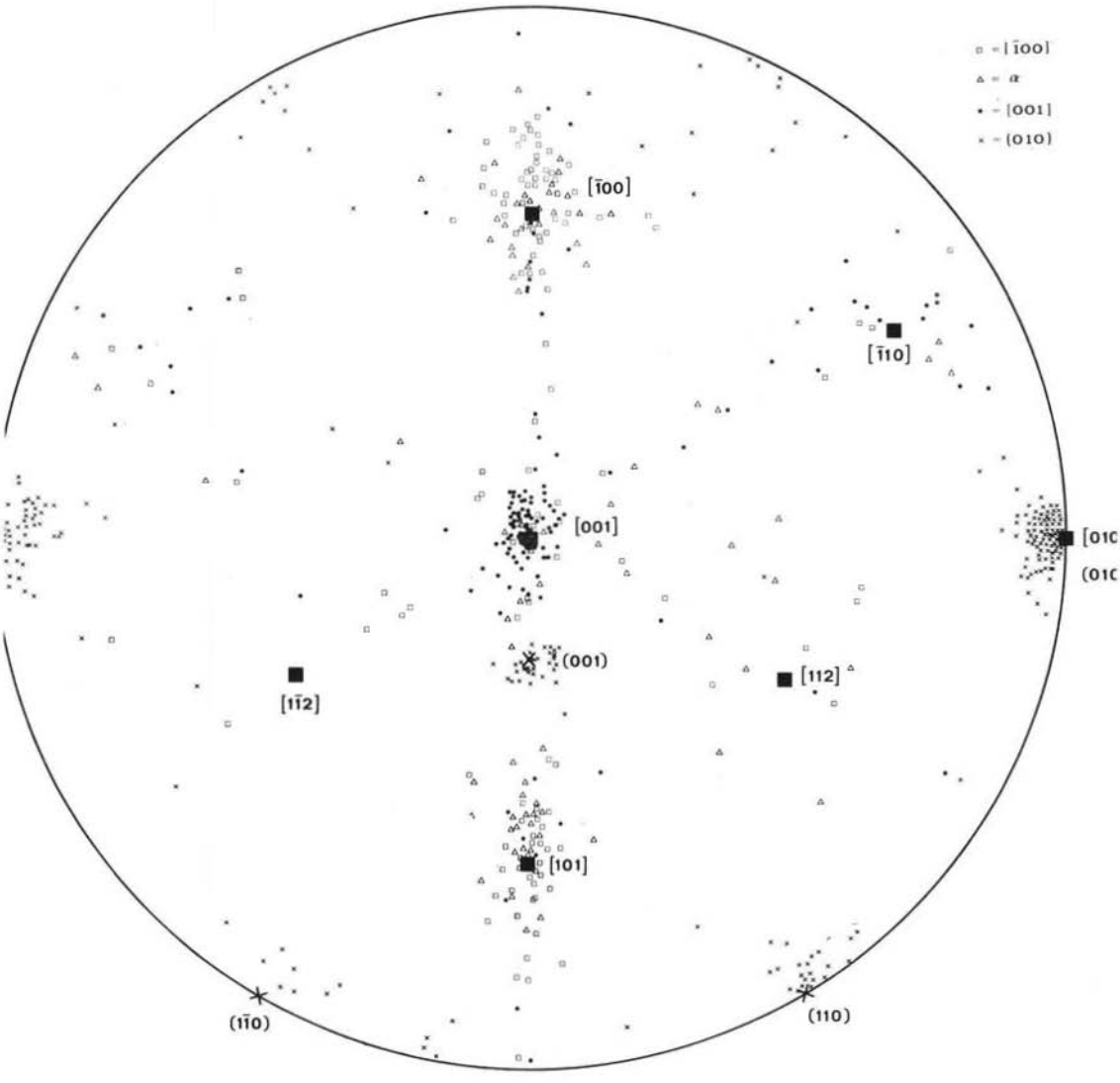

Fig. 2. — Stereographic projection of all the measured plagioclases against the standard projection of the K-feldspar; □ (squares) represent [100] axis; × (crosses) (010) planes; · (points) [001] axis and △ (triangles) the X-axis of the optical indicatrix. Some important crystallographic directions of K-feldspar are also reported.

tion has been made between the different observed twin types. All the partial totals are reported.

Table 2 reports the data about the three-dimensional orientation of Albite-Karlsbad twinned plagioclases. Eleven modes labelled *a* through *m*) of three-dimensional orientations have been recognized. The more interesting crystallographic features of four of these eleven modes are schematically represented in figure 3.

TABLE 1.

Orient.	Twin	Thin Section			Totals
		A	B	C	
{010}	A-K	17	13	51	81
	Ab	11	25	38	74
	K	1	—	—	1
		29	38	89	156
{001}	A-K	7	5	—	12
	Ab	8	12	—	20
	M	1	—	—	1
		16	17	—	33
{110}	A-K	2	—	19	21
	Ab	4	—	18	22
	K	—	—	2	2
		6	—	39	45
No oriented	A-K	2	2	4	8
	Ab	5	2	8	15
	M	1	—	—	1
	P	1	—	1	2
		9	4	13	26
No determined		5	7	14	26
Totals		65	66	155	286

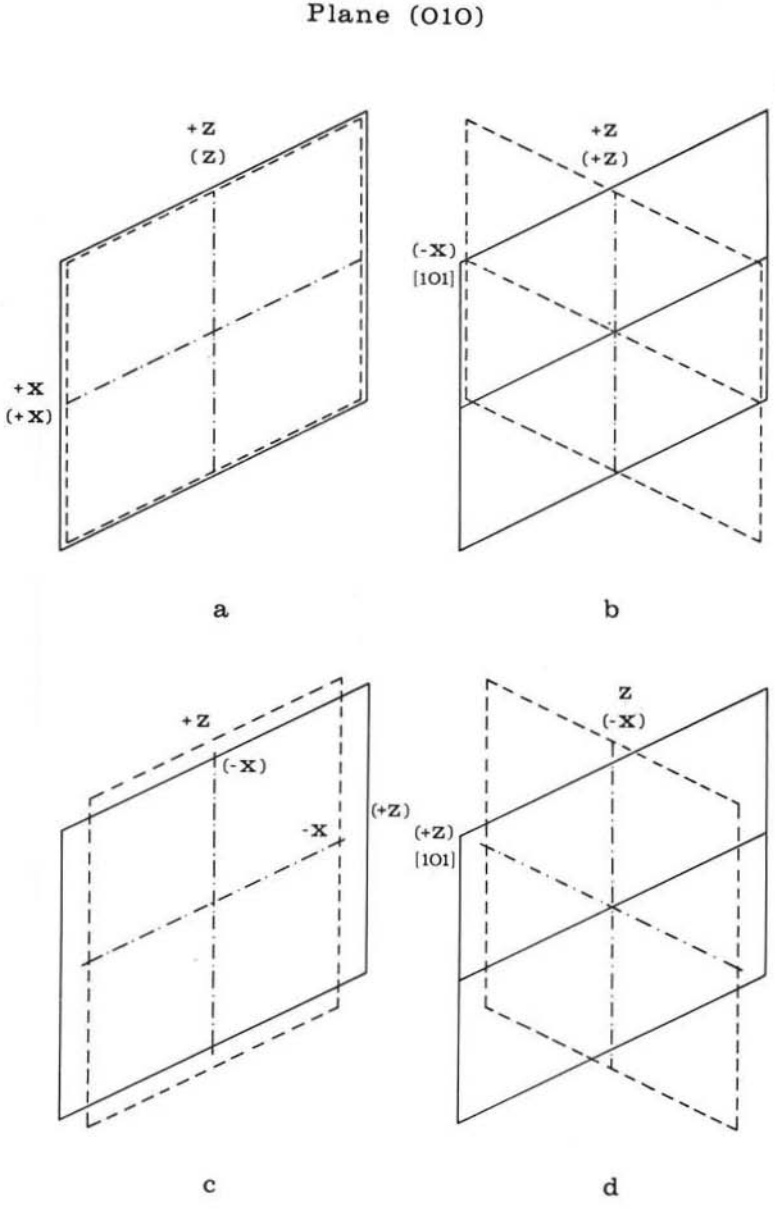

Fig. 3. — The figure represents on the (010) plane the four observed orientations of the plagioclase net (dotted line) against the K-feldspar net (continuous line).

TABLE 2. — *Albite-Karlsbad Twins.*

Orientation					Section			Totals
Plag.	{010}	[001]	[$\bar{1}$00]		A	B	C	
K-Feldsp.	{010}	[001]	[$\bar{1}$00]	(a)	6	3	21	30
			[101]	(b)	10	3	19	32
		[$\bar{1}$00]		(c)	—	1	1	2
		[101]		(d)	—	4	5	9
		n.o			1	2	5	8
					17	13	51	81
K-Feldsp.	{001}	[$\bar{1}$00]		(e)	1	—	—	1
		[$\bar{1}$10]	[$\bar{1}$00]	(f)	5	3	—	8
			[110]	(g)	—	2	—	2
		n.o			1	—	—	1
					7	5		12
K-Feldsp.	{110}	[001]	[$\bar{1}$10]	(h)	—	—	2	2
			[1$\bar{1}$2]	(i)	—	—	6	6
		[$\bar{1}$10]	[001]	(l)	—	—	5	5
			[$\bar{1}\bar{1}$2]	(m)	—	—	2	2
		n.o			2	—	4	6
					2	—	19	21
		Totals			26	18	70	114

Table 3 reports partial data collected on Albite twinned plagioclases. These partial data show the same crystallographic features observed in the Albite-Karlsbad twinned plagioclases.

TABLE 3. — *Albite Twins.*

	Orientation		Thin Section			Totals
Plag.	{010}	α	A	B	C	
K-Feldsp.	{010}	[$\bar{1}$00]	2	10	9	21
		[001]	1	1	3	5
		[101]	2	6	13	21
		n.o	4	—	2	6
		n.d	2	8	11	21
			11	25	38	74
K-Feldsp.	{001}	[$\bar{1}$00]	7	5	—	12
		[$\bar{1}$10]	—	3	—	3
		n.o	—	—	—	—
		n.d	1	4	—	5
			8	12	—	20
K-Feldsp.	{110}	n.o	4	—	18	22
			4	—	18	22
	Totals		23	37	56	116

Discussion of results.

It has been possible to measure the orientation (total or partial) of 260 out of a total of 286 observed plagioclases laths. Of these 260 measured plagioclases only 26 don't show any clear evidence of simple crystallographic orientation against K-feldspar. The first obvious rule is that the {010} plagioclase planes are parallel to {010} or {001} or {110} K-feldspar planes.

This fact can be interpretated as a consequence of the morphology of the two minerals. The plagioclases are essentially represented

by laths with great development of {010} planes. The KFm show well developed {010} faces accompanied by {001} pinacoid and {110} prism.

The relative frequency of the three observed orientations of plagioclase laths are roughly proportional to the relative development of the KFm faces.

For what concern the three dimensional rules of isoorientation we can utilize only the data on Albite-Karlsbad twins (table 2).

It appears clear that first of all the synneusis structures are conditioned by the morphological development of the two minerals that partecipate to the formation of such structure.

The isoorientation between the planes {010} of plagioclase and {110} of K-feldspar cannot surely be explained claiming simple relations between the nets on these two planes. We conclude therefore that obviously to develop synneusis structures the two minerals would have developed faces.

However the morphological development, although preminent in the formation of synneusis structures, is not the only determining factor. We observe in fact that on a total of 114 measured Albite-Karlsbad twinned plagioclases, 99 show a preferential isoorientation of their net against that of K-feldspar.

Table 2 shows all the observed isoorientations. Of particular interest is the situation of plagioclases with their {010} planes parallel to the ones of K-feldspar.

Of the four observed orientation there are two (*a* and *b* in figure 2) which are greatly favoured. The one (*a* orientation) has the axis of plagioclases parallel to the ones of K-feldspar. The other (*b*) has the axis of plagioclases related to the ones of K-feldspar as through a Karlsbad twin.

The other two orientation, for which there is a certain misfit between the axis of plagioclases and K-feldspar, are many times more rare.

The same situation is observed for the other orientation although the picture is not so clear owing to the scarce number of plagioclases with their {010} planes parallel to {001} planes of K-feldspar.

The data of table 3, although not complete, point out toward the same conclusion.

Conclusion.

The present study has shown that 90% of the plagioclase laths contained in the K-feldspar megacrysts of the M.te Capanne (Elba Island, Italy) granodiorite and its associated dikes, are isooriented against the host K-Feldspar.

This situation can be explained only as due to synneusis phenomena. On the basis of the Vance hipothesis (1969) we have to conclude that the K-feldspar megacrysts are of magmatic origin and that their crystallization has taken place in presence of a liquid phase in which free moviment of crystals was possible.

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