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# A new occurrence and a structural interpretation of the sanidine Nevada twin

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SUMMARY. A new example of the Nevada twin from the Mont-Dore (Massif Central, France) is described. A structural interpretation of the twin is given assuming a ($0\bar{2}1$) composition plane parallel with the chains of the feldspar structure.

AMONG the numerous sanidine twins, some are very common and are found almost everywhere; such are the Carlsbad or Baveno twins. Others are unusual and found only in peculiar localities; the Nevada twin belongs to this latter group. It was described for the first time by J. Drugman (1938) in an issue of this Journal, and was found in a large collection of sanidine crystals found near Goodsprings (Nevada). The twin is by penetration with [$\bar{1}12$] as the twin-axis. Following G. Friedel's law there exists a reticular plane, namely ($\bar{1}11$), almost perpendicular to the twin-axis; the obliquity is about 6°.

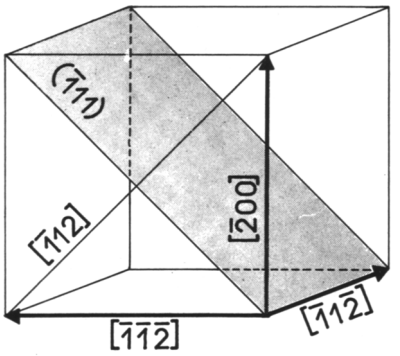



FIG. 1. Pseudo-cubic cell of feldspars, drawn ideally as a perfect cube, with elements of the Nevada twin.

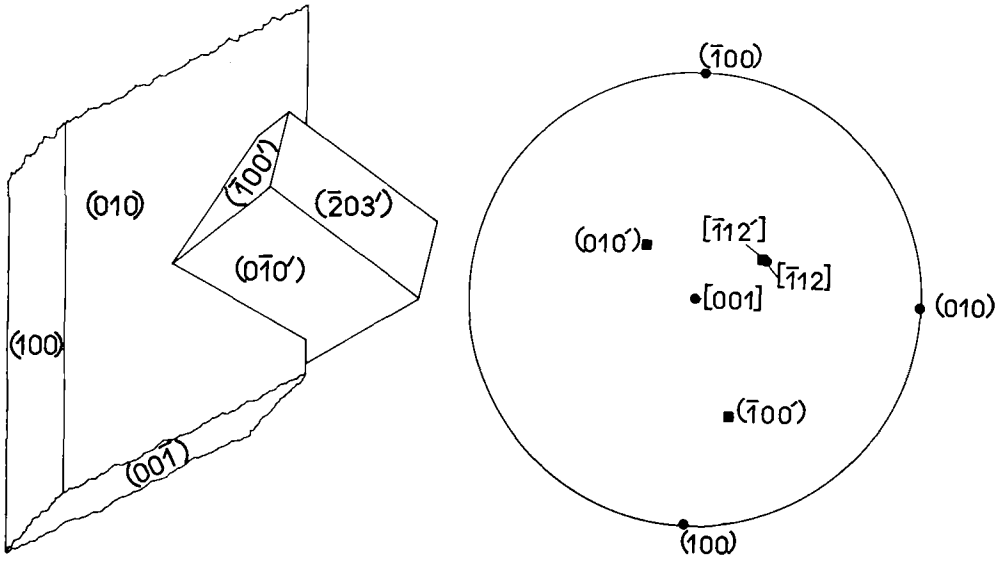
The twin fits well the general synthesis of feldspar twins given by C. Burri (1962). This synthesis is based on the existence of a feldspar multiple cell that is nearly cubic. All pseudo-binary axes and pseudo-mirrors of this pseudo-cubic cell are potential twin-axes and twin-planes. As shown in fig. 1, the twin-axis [$\bar{1}12$] joins two opposite corners of a face of the pseudo-cubic cell and, accordingly, is a pseudo-binary axis. The plane ($\bar{1}11$), nearly perpendicular to [$\bar{1}12$], is a diagonal plane of the pseudo-cubic cell.

Since J. Drugman's finding, no other occurrence of this twin seems to have been reported.

*A new occurrence of the Nevada twin.* Sanidine is very common in the Mont-Dore old volcano (Massif Central, France), particularly in sancyite, a trachytic rock of widespread occurrence. But usually sancyite is a hard rock and it is difficult to extract the delicate sanidine crystals without completely breaking them.

During a trip along the south-west slope of the volcano, I had the chance to find an extensive outcrop of well-altered sancyite out of which it was easy to extract many

sanidine crystals.[1] One of them, formed by two individuals (fig. 2), drew particular attention. The first individual shows only the combination {100} and {010}. The ends are broken along the cleavage (001). The second individual, which runs through the first one, is terminated at one end by the combination {100} {010} and the unusual face ($\bar{2}03$). The other end is undeterminable. A powder diffractogram of a small piece




FIGS. 2 and 3: FIG. 2 (left). Specimen of the Mont-Dore sanidine showing Nevada twin. FIG. 3 (right). Stereographic plot of the twin. Circles for one individual; squares and notation with prime for the other.

of the first individual gives the composition $Ab_{53}Or_{47}$ (mole %) according to the position of the $\bar{2}01$ reflection using P. M. Orville's graph (1967). Angular determinations on the specimen, supplemented by knowledge of the cell parameters corresponding to the composition quoted above (P. M. Orville, 1967), allow the construction of the stereographic plot fig. 3. This plot shows that the two individuals share the [$\bar{1}12$] row and can be deduced from one another by a half-turn around this direction. Thus the two individuals are related by the Nevada law.

*Structural interpretation of the Nevada twin.* As is well known, a characteristic feature of the feldspar structure is the presence of chains running along [100] (W. H. Taylor, 1933; W. F. Cole, H. Sörum, and O. Kennard, 1949).

It is assumed that the composition plane of the twin is parallel with this important direction. Containing [100] and [$\bar{1}12$] it has the notation ($0\bar{2}1$). More precisely we assume that the composition plane ($0\bar{2}1$) goes through centres of symmetry of the

[1] The exact location is at the foot of the 'Roc de Courlande' at the coordinates: 634, 0 ($x$) 358, 9 ($y$) (1.50.000 map from the Institut Géographique National).

structure midway between adjacent feldspar chains. This plane is chosen as the plane of fig. 4*a*. Centres of symmetry are, in this plane, at the intersections of the net built on the rows [100] and [$\bar{1}$12]. Immediately beneath is a feldspar chain, the projection of which is sketched; heavy lines are drawn connecting the silicon atoms in order to visualize this chain simply and oxygen atoms linking silicon atoms in the chain are not shown. Further chains are produced by translation along [$\bar{1}$12].

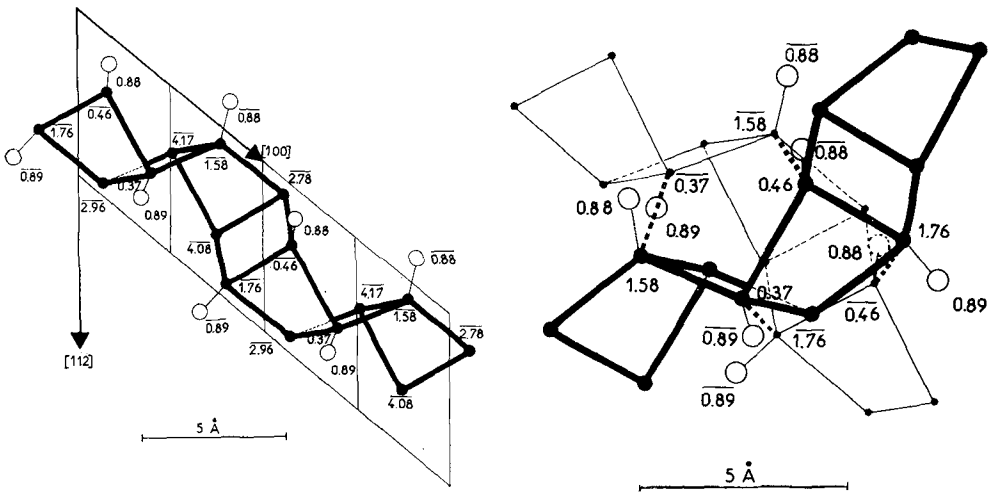



FIG. 4. *a*, left: Projection of the feldspar structure on the composition plane (o$\bar{2}$1). Centres of symmetry at the intersections of the net. Silicon atoms: black circles. Oxygen atoms: blank circles. Atomic heights in angströms. *b*, right: Projection on the composition plane (o$\bar{2}$1) of a 'twinned' and an 'untwinned' chain showing the connections between them as heavy pecked lines.

In the untwinned structure other parallel chains lie above and are related to the sketched one by the centres of symmetry. Oxygen atoms, represented as blank circles, bind the sketched chain to the chains lying above. In the twinned structure the chains lying above are related to the sketched one by a half-turn around [$\bar{1}$12]; such a 'twinned chain' can be translated above the 'untwinned' into a position where the linking oxygen atoms occupy pairs of neighbouring sites (fig. 4*b*). Each pair can merge into a single site by a small displacement of the atoms, not exceeding 1 Å. In this way it is possible to bind the upper silicon atoms of the 'untwinned chain' to the lower silicon atoms of the 'twinned'. The bound atoms are connected by heavy pecked lines in fig. 4*b*.

In fact these atoms seem a little too close for a normal Si–O–Si bounding. In the given positions the Si–Si interatomic lengths range from 2·44 to 2·90 Å. A greater separation of the two halves of the twin is required in order to get better interatomic lengths. If the separation increases by 0·6 Å correct lengths, ranging from 2·98 to 3·36 Å, are obtained. In other words the composition plane must not be in the plane of the figure, as assumed, but about 0·3 Å above it.

As can be seen, this interpretation is reminiscent of the classic interpretation of the Carlsbad twin; but in the Nevada twin, the composition plane not being a symmetry plane, the detailed geometry of the twin is more involved.

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