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Inverse Pole-Figures of two Carbonate Fabrics

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With 1 figure in the text

Abstract. — Two inverse pole-figures are presented for a calcite and a dolomite fabric from the Lepontine area. The two fabrics were earlier described in this journal. The inverse pole-figure is used to represent compactly and completely data on preferred orientation for axially symmetric fabrics.

Recent studies on preferred orientation of quartz aggregates have shown that the information on preferred orientation of the crystallites can be represented, in the case of axially symmetric fabrics, compactly and completely with the inverse pole-figure. The inverse pole-figure is simply the preferred orientation of the unique fabric symmetry-axis (r) with respect to the crystal axes (Baker et al., 1968; Wenk et al., 1967; Wenk and Kolodny, 1968). In quartz only the c-axis can be measured optically. This does not give enough information to derive the inverse pole-figure. However, the inverse pole-figure can be calculated from pole-figures of various planes (taken with x-ray analysis) using a rather sophisticated spherical harmonic analysis (Roe, 1965; Baker et al., 1968).

In calcite and dolomite belonging to the point groups $\bar{3}$m, $\bar{3}$ respectively, planar morphological elements (cleavage and twin planes) are ubiquitous and specify together with the optic axis [0001] the orientation of the grains completely. The inverse pole-figure is constructed by rotating the crystallographic axes of all crystals to coincidence and plotting the specimen symmetry-axis. In contrast to natural quartz fabrics, natural carbonate fabrics often approximate axial symmetry so that the inverse pole-figure technique can be applied.

The inverse pole-figure was derived for a calcite and a dolomite fabric from marble-zones in high grade metamorphic mesozoic sediments of the Central

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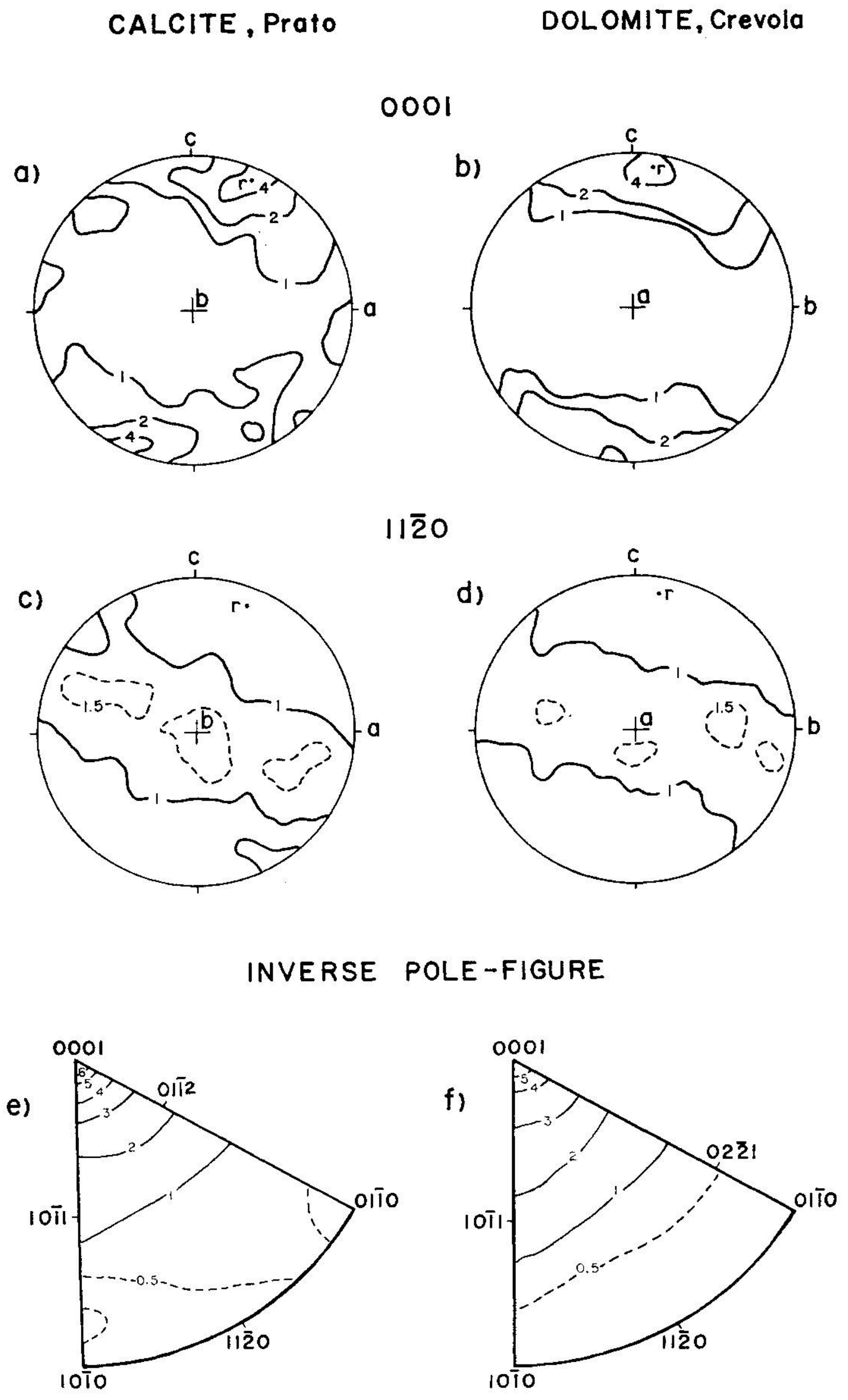

Fig. 1. Diagram on preferred orientation for the calcite fabric from Val Prato (533 grains) and the dolomite fabric from Crevola (955 grains). Concentrations are given in multiples of uniform distribution.

a, b: Pole-figures for [0001] (a, b, c are microscopic fabric coordinates, *r* is the symmetry axis).

c, d: Pole-figures for (11$\bar{2}$0).

e, f: Inverse pole-figures.

Alps (Lepontine). The two specimens had previously been subjected to AVA, and an analysis of neighbor-grain statistics. Pole-figures for different crystallographic directions have been constructed (TROMMSDORFF, 1964; TROMMSDORFF and WENK, 1965; WENK and TROMMSDORFF, 1965). The data of all these pole-figures are now presented compactly in a single sector of 60° on the hemisphere extending from [0001] to $[10\bar{1}0]$ and $[01\bar{1}0]$.

The c-axis pole-figures (Fig. 1) of the calcite marble from Val Prato (Ticino) and the dolomite-marble from Crevola (Novara) show a fair approximation to axial symmetry. The symmetry-axis (r) is in both cases slightly but characteristically inclined to the pole of the foliation plane (c). The a-axes $(11\bar{2}0)$ also show distribution patterns with a roughly axial symmetry (WENK and TROMMSDORFF, 1965) (Fig. 1c, d). Therefore, preferred orientation can be represented by the inverse pole-figure (Fig. 1e, f). The inverse pole-figures were constructed both graphically and later calculated by a computer. The results are identical. To our knowledge it is the first construction of an inverse pole-figure for petrofabrics from direct measurements.

These two *inverse* pole-figures show — within the range of statistical significance — good axial symmetry. The deviations are insignificant because they are smaller than the deviation from axial symmetry in the direct pole-figures. Contrary to the situation in recrystallized quartz fabrics (BAKER et al., 1968), or to cold-worked calcite, in this carbonate fabric there is *no* visible difference in the preferred orientation of positive and negative rhombohedra. The specimen symmetry-axis has freedom of rotation around the c-axis [0001], similar to quartz fabrics in chert (WENK and KOLODNY, 1968).

This type of fabric is widespread over a large area and seems to represent a steady-state orientation (TURNER and WEISS, 1963) for recrystallized calcite and dolomite marbles in the Lepontine Alps.

A strong preferred orientation of c-axes parallel to the maximum principal stress-component σ_1 is the general pattern observed in experimentally recrystallized calcite and dolomite marbles (GRIGGS, TURNER and HEARD, 1960; NEUMANN, 1967). The fabrics of the two marbles are similar to those produced by recrystallization under uniaxial compression normal to the foliation.

References

BAKER, D. W., H.-R. WENK and J. M. CHRISTIE (1968): X-ray analysis of preferred orientation in fine-grained quartz aggregates. (In preparation.)

GRIGGS, D. T., F. S. TURNER and H. C. HEARD (1960): Deformation of rocks at 500° to 800° C. Geol. Soc. Am. Memoir 79, 39—104.

NEUMANN, E. (1967): Experimental recrystallization of dolomite under stress. M. S. thesis, U. C. L. A.

ROE, R. J. (1965): Description of crystallite orientation in polycrystalline materials. III General solution to pole figure inversion. J. Appl. Phys. 36, 2024—2031.

Trommsdorff, V. (1964): Gefügestudien an Calcitmarmor aus Val Prato (Tessin). Schweiz. Mineral. Petrogr. Mitt. 44, 595—611.

Trommsdorff, V. und H.-R. Wenk (1965): Die Regelung des Dolomites von Crevola (Simplon-Gruppe). Ergebnisse und Probleme. Schweiz. Mineral. Petrogr. Mitt. 45, 551—569.

Turner, F. J., and L. E. Weiss (1963): Structural analysis of metamorphic tectonites. New York.

Wenk, H.-R., D. W. Baker and D. T. Griggs (1967): X-ray fabric analysis of hot-worked and annealed flint. Science 157, 1447—1449.

Wenk, H.-R. and Y. Kolodny (1968): Preferred orientation of quartz in a chert breccia. Proc. Nat. Acad. Sci. 59, 1061—1066.

Wenk, H.-R. und V. Trommsdorff (1965): Koordinatentransformation, mittelbare Orientierung, Nachbarwinkelstatistik. Gefügekundliche Rechenprogramme mit Beispielen. Beitr. Mineral. Petrogr. 11, 559—585.

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