

Note on tridymite in rock 12021

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(Received 22 February 1971; accepted 25 March 1971)

Abstract—Tridymite constitutes ~ 5% of pigeonite porphyry 12021 and from textural evidence appears to have crystallized simultaneously with groundmass clinopyroxene and plagioclase.

At room temperature this tridymite has the same monoclinic unit cell found previously for tridymite from meteorites and from silica brick fired at ca. 1400°C. The single crystal X-ray diffraction pattern is distinct from that of vug-filling, terrestrial volcanic tridymite, which probably crystallized at much lower temperature.

THE COARSE grained pigeonite porphyry 12021 contains an unusual abundance of well crystallized silica polymorphs, among which tridymite is most abundant and makes up about 5% of the groundmass. We have examined tridymite petrographically in thin section 12021,135 and by X-ray diffraction on several single grains separated from 12021,51. APPLEMAN *et al.* (1971) have also reported X-ray data on tridymite from the same rock. In contrast to cristobalite which occurs interstitially, the tridymite forms large skeletal to subhedral grains intergrown with plagioclase and calcium rich clinopyroxene. Typical subhedral grains are 200–500 $\mu \times 50 \mu$ while skeletal grains are up to a millimeter in length. Textural relationships between tridymite and plagioclase and granular clinopyroxene suggest that all three were crystallising at the same time, and possibly earlier than rosettes of acicular clinopyroxene and plagioclase.

Single-crystal X-ray diffraction photographs showed the prominent (pseudo) hexagonal subcell characteristic of all tridymites ($a = 5$, $c = 8.2 \text{ \AA}$). In addition to this strong subcell pattern a weaker but clearly defined monoclinic cell with space group Cc or $C2/c$ and $a = 18.52$, $b = 4.98$, $c = 23.79 \text{ \AA}$, and $\beta = 105.6^\circ$ is readily apparent. This room temperature cell is virtually identical to that previously reported for tridymites from three different meteorites and from ceramic silica-brick (DOLLASE, 1967). The silica brick tridymite was formed in a furnace heated to near 1400°C for several years. HOFFMAN (1967) reports the same cell for tridymite grown on quartz chips in sodium tungstate flux at 1100°C in 20 days.

In contrast the common occurrence of natural terrestrial tridymite is as vesicle fillings in volcanic rocks of various types. Tridymites from such occurrences are found to have pseudo-hexagonal (twin-composite) cells of $a = 10$, and $c = nx 8.2 \text{ \AA}$, where $n = 2, 5$, or 10 (FRONDEL, 1962). Although the detailed diffraction patterns of these two groups of tridymites are then distinctly different it was found that on very long exposure Cu-radiation precession photos of 12021 tridymite there appeared a few unexplained, faint, diffuse reflections and streaks whose appearance and locations are

somewhat reminiscent of the superstructure reflections seen with terrestrial tridymites.

The variation in birefringence with temperature of 12021 tridymite was monitored by means of Senarmont compensation on a hot stage. On heating a sharp drop in the birefringence was noted at ca. 109°C; this was subsequently reversed at ca. 80°C on slow cooling. Very similar results were obtained with Steinbach meteoritic tridymite where this sharp drop in birefringence (at ca. 107°C) is known to accompany a displacive polymorphic transformation from the room-temperature form to orthorhombic high tridymite (DOLLASE, 1967). (Terrestrial vug-filling tridymites show analogous optical effects at higher temperature, 140–160°C.)

The similarity of the X-ray diffraction pattern of tridymite from 12021 with that of synthetic tridymite, crystallized at ~ 1400°C, is consistent with the idea that this tridymite also crystallized within its stability field, rather than metastably like most vesicle-filling terrestrial tridymite. In view of the high alkali concentrations measured in 12021 tridymite (CLIFF *et al.*, 1971) the stability field may have been enlarged above that of pure tridymite, but it is also possible that the measured alkalis are located in the numerous small glass inclusions. The textural evidence is consistent with relatively high temperature crystallization in that tridymite appears to be part of the main crystallization sequence which began while much of the rock was still liquid.

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