pyroxenes. The granulites consist of pyroxenes and plagioclase (An_{35} to An_{60}) sometimes with garnet, and having amphibole, apatite, opaques, and quartz as accessories. The six analysed orthopyroxenes (Table I) range from En_{58} to En_{75}. The Al content is variable but generally high and is not apparently related to host rock Al_2O_3 or the composition of the coexisting plagioclase and so it is suggested that high pressure is important, following previous opinions (e.g. Leelanandam, 1967). The six analysed clinopyroxenes (Table I) are sahlites with one ferroaugite. The metamorphic and igneous clinopyroxenes coexisting with orthopyroxene do not exhibit significant differences of trend. The ratio $(Fe^{2+}/Mg)_{opx}/(Fe^{2}/Mg)_{cpx} = K_p$ obtained for the five coexisting pyroxene pairs varies from 1·7 to 1·8. Bartholome (1962), Kretz (1963), and Engel, Engel, and Havens (1964) have constructed a diagram showing K_p as function of temperature of crystallization. This gives an average temperature of around 650° for the present rocks.

The distribution coefficient

$$K_D = [Mn/(Mg+Fe^2+Mn)]_{opx}/[Mn/(Mg+Fe^2+Mn)]_{cpx}$$

is 1·1 for the granulites with one sample having 1·2. Kretz (1963) suggested 1·2 is the K_D value for the granulite facies. From K_p and K_D then it may be suggested that the pyroxenes attained chemical equilibrium in the granulite facies.

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REFERENCES

BARTHOLOME (P.), 1962. *Geol. Soc. Amer., Buddington vol.*, 1.
ENGEL (A. E. J.), ENGEL (C. G.), and HAVENS (R. G.), 1964. *Geol. Soc. Amer. Bull.* **72,** 131.
KRETZ (R.), 1963. Ibid. **71,** 773.
LEELANANDAM (C.), 1967. *Min. Mag.* **36,** 153.

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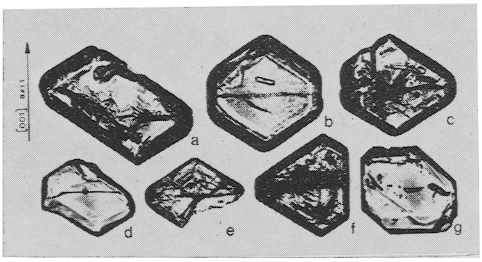
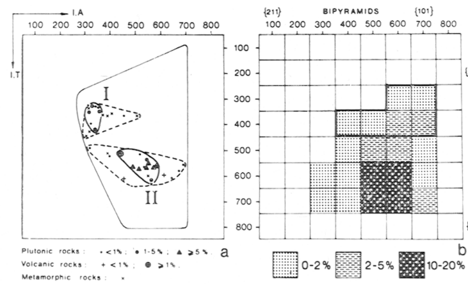
Occurrence of peculiar tabular zircon crystals

DURING a systematic study of zircon typology in endogenous rocks, we were led to examine the distribution of tabular zircon mentioned by Phillips (1974) as existing in these types of rocks; 245 samples were studied.

We found, like Phillips, that this tabular zircon is made up of idiomorphic grains flattened on two faces {110} and shows an elongation ratio less than 1. These zircons correspond to the subtypes S_{3-4-5}, S_{8-9-10}, and more rarely P_{1-2} according to the typological classification of Pupin and Turco (1972a). Most of the grains are clearly zoned, but some of them show no visible zoning (fig. 1d). Some crystals are plainly disymmetrical (fig. 1a). A characteristic not mentioned but figured by Phillips is the quasi-constant presence in the central part of those crystals of a more or less rectilinear mark, perpendicular to the [001] axis. This mark apparently corresponds to the point where faces {211} joined during the growth of the crystal, and sometimes even looks like the limit of a parallel growth (fig. 1c). It is also a zone of weakness and becomes a preferential breaking-point in certain crystals (fig. 1e).





FIGS. 1 and 2: FIG. 1 (left). Tabular zircons: a–e, xenolith of granodiorite in the Velay granite, La Palisse, France; f, rhyolitic dyke near Plan de la Tour, Maures, France; g, hololeucocratic trachyandesite, Mont-Dore, France. Crystal lengths are about 0·15–0·25 mm. FIG. 2 (right). a. Distribution of endogenous rocks possessing peculiar tabular zircons in the diagram (I.A, I.T), where each population figures with its mean point ($\bar{\text{I.A}}$, $\bar{\text{I.T}}$) (I.A = Indice A = relative development of pyramids (101) and (211), I.T = Indice T = relative development of prisms (101) and (110)) (Pupin and Turco, 1972a–c, 1974a–b, 1975). In the sets I and II (dashed outlines) the areas corresponding to the populations richest in tabular zircons are delimited by a heavily drawn line; the outer and more lightly drawn line marks the distribution limits of the 245 samples studied. b: Typological distribution of the zircons (with the respective frequencies of the subtypes) in the population from the granodiorite of Grimsel, Aar, Switzerland. This rock contains about 2 % of tabular zircons distributed in the marked-off zone (I.T. = 300–400).

Of 142 plutonic rocks studied, tabular zircon was found in certain granites, adamellites, and granodiorites and may reach 18 % of the total zircon population (e.g. in the adamellite-granodiorite in the Liron Massif, Saint-Jean-du-Gard, France). As far as we know, this type of crystal is absent from diorites, quartzitic diorites, syenites, alkaline granites, and leucogranites (in the opinion of Didier and Lameyre, 1969). Of forty-five volcanic rocks studied, only certain kinds of rhyolitic lava or tuff possess tabular zircons (fig. 1g); the latter are absent from basalts, trachyandesites, trachytes, and phonolites. In fifty-eight metamorphic rocks examined, such as migmatites and anatexites, recrystallized tabular zircon is very rare (less than 1 %); it can also be found in rocks of ortho origin (old granites and rhyolites).

In the diagram (I.A, I.T) (Pupin and Turco, 1972b, 1974a–b, 1975) (fig. 2a), the thirty-seven zircon populations with tabular crystals can be grouped in two sets, I and II, which are of more limited distribution than the total set of endogenous rocks. This would seem to indicate that tabular crystals are only present in zircon populations showing a particular typological distribution. For example, the typological distribution of a granodiorite of set II (fig. 2b) shows that the tabular crystals have the greatest development of the prism {110}, which would seem to indicate, according to the geothermometrical data of zircon (Pupin and Turco, 1972c), that these crystals were the last to appear in these populations. Crystals of this kind thus represent a highly particular mode of occurrence and must be distinguished from other sorts of tabular zircons with an elongation ratio less than 1, dominant prism {100} and lack of the central mark previously defined, such as that of fig. 1g.

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REFERENCES

DIDIER (J.), and LAMEYRE (J.), 1969. *Contr. Min. Petr.* **24,** 219–38.
PHILLIPS (E. R.), 1974. *Min. Mag.* **39,** 715–16.
PUPIN (J. P.) and TURCO (G.), 1972a. *Bull. Soc. franç Min. Crist.* **95,** 348–59.
—— —— 1972b. *Compt. Rend. Acad. Sc. Paris, D,* **275,** 799–802.
—— —— 1972c. Ibid. *D,* **274,** 2121–4.
—— —— 1974a. *Bull. Soc. franç. Min. Crist.* **97,** 59–69.
—— —— 1974b. *Compt. Rend. Acad. Sci. Paris, D,* **278,** 2719–22.
—— —— 1975. *Petrologie,* **1**(2), 139–56.

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Compositional relationships of Fe–Ni alloy and coexisting phases in serpentinite, Red Mountain, New Zealand

CHALLIS (1975) noted a range in composition of detrital Fe–Ni alloys in the Jerry and Gorge Rivers of south Westland, New Zealand. She attributed this range, from weight per cent Ni_{67} to $Ni_{96.3}$, to partial removal of iron during fluvial transport, analogous to the process of natural refining of gold (Lindgren, 1928; Challis, 1975).

The Red Mountain area of north-west Otago and south Westland includes the dominantly harzburgitic peridotite mass near the head of the Jerry River, and probably provides the source for much or all of the ultramafic detritus in it. Most of the altered peridotites at Red Mountain contain sulphide and alloy minerals, including pyrrhotine, pentlandite, heazlewoodite, native copper, and Fe–Ni alloys. These minerals are present only in serpentinites and in serpentine veins in weakly altered peridotites; unaltered Red Mountain peridotites do not contain sulphides nor alloys. Many of the opaque grains in Red Mountain rocks are composite aggregates of