elsewhere. Joesmithite has 23 atoms in the asymmetric unit, presented in table I.

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A comparison of Grenville and Lewisian granites

It is generally agreed that for a given cycle of plutonic activity older granites tend to be rich in sodium relative to potassium, while younger ones tend to be rich in potassium relative to sodium (Read, 1949, pp. 148–149). Bowes (1967) has demonstrated a compositional trend of this kind for Lewisian granites, which he interprets in terms of Read's Granite Series.

Table I

	Mineralogy	Mode of occurrence	Lewisian type similar in composition
Type I*	30% quartz, 45% plagioclase (An_{15}–An_{30}), 10% microcline, 10% biotite. Hornblende common.	1. Grey, well-foliated gneiss. 2. Granitic layers in migmatite. 3. Massive granite with angular xenoliths. 4. Dike.	Autochthonous
Type II	35% quartz, 30% plagioclase (An_5–An_{20}), 25% microcline, 2% biotite. Perthite common.	1. Pink, well-foliated gneiss. 2. Granitic layers in migmatite. 3. Discordant lenses and phacoidal bodies. Xenolithic in places. 4. Dikes and veins.	Parautochthonous
Type III	20% quartz, 20% plagioclase (An_0–An_{10}), 55% microcline. Perthite common, biotite masses in some pegmatites.	1. Dikes and veins⎫commonly 2. Tabular sheets ⎭pegmatitic. 3. Patches of graphic granite in type II granite.	Intrusive

* South of the Haliburton Highlands, granite of this kind occurs in the Weslemkoon and Elzevir discordant plutons, see Lumbers, 1964, fig. 7.

The Lewisian granites provide an interesting basis of comparison for Precambrian granites associated with metasedimentary and metavolcanic rocks of the Grenville province and outcropping in the Haliburton Highlands of Ontario. Salient features of the Canadian granites are shown in table I and their normative compositions in fig. 1.

Despite compositional similarities, the Grenville granites, unlike the Lewisian, do not fall into a simple sequential Granite Series. Certainly the most sodic granite (Type I of table I) is the oldest, being cross-cut by many veins and dikes of Types II and III granite; but there is no unequivocal evidence that Type II is intermediate and Type III is youngest in such a sequence. Indeed, several lines of evidence suggest that the two are penecontemporaneous.

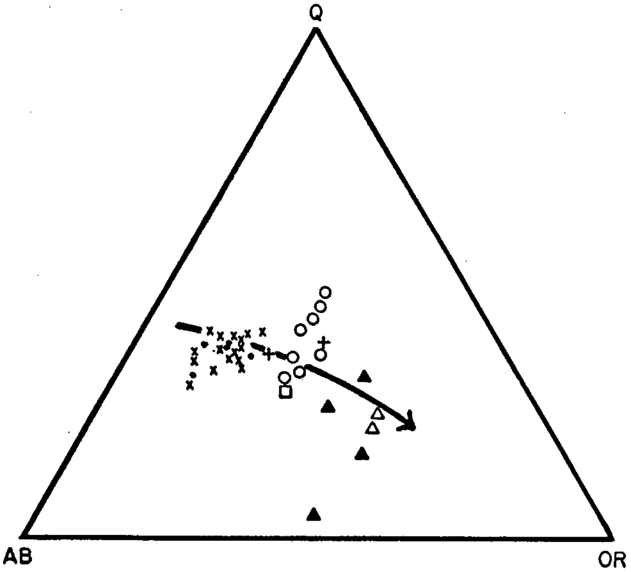

FIG. 1. Normative compositions of granitic rocks occurring in Glamorgan township, Ontario. Based on unpublished analyses. *Type I*: ● gneiss; × granitic bands in migmatite. *Type II*: ○ gneiss; + granitic bands in migmatite; □ dike. *Type III*: △ graphic granite; ▲ pegmatite veins. The arrow shows the approximate trend of Lewisian granites with respect to time.

For example, both are found together in composite dikes, Type II forming the core and Type III the rims. Some outcrops have Type II cross-cutting Type III veins. Elsewhere the relationship is reversed. The two types are intimately interlayered in the contact zones of a phacoidal body of granite in Glamorgan township and the same pluton contains ill-defined patches of a graphic variant of Type II grading into Type III granite.

A second contrast concerns the role of igneous processes in the two occurrences. Intrusive bodies (i.e. veins, dikes, and larger discordant plutons, containing xenoliths in places) of all three types of granite are found in the Grenville province of south-eastern Ontario and provide field evidence of magmatic activity. Nevertheless, the compositional spread of the Grenville granites is similar to that of the Lewisian and according to Bowes (1967, p. 359) the Lewisian sequence 'is transverse to the compositional trend that the evidence of experimental studies suggests would be the case if melting and magmatic crystallization were the dominant processes involved'. From this he concluded that the Lewisian rocks are not igneous.

It is true that the spread of analyses (fig. 1) is transverse to fractionation curves determined in experimental studies (e.g. Tuttle and Bowen, 1958, p. 65). However, the experiments deal solely with phase equilibria in the presence of an aqueous 'vapour' (i.e. $P_{E_{H_2O}} = P_{solid}$). They can only serve as guides to a natural case for which there is evidence that a melt was saturated with respect to H_2O. Such a case is most likely when the amount of melt is small (e.g. in the first stage of melting, or the final stage of fractionation) or when the solubility of H_2O in the melt is small (e.g. in a pluton emplaced at a high level in the crust). It is least likely to hold for large bodies of magma in deep regions of the crust; and according to Buddington (1959, p. 728) the granitic rocks of the Haliburton Highlands were emplaced at least partly in the catazone.

Furthermore, the evolution of a series of granites need not be an equilibrium phenomenon. An originally homogeneous magma could develop a compositional gradient by differential diffusion of chemical components in response to a temperature gradient. It could thus evolve into relatively sodic and relatively potassic zones, and lead to the kind of age relationship shown by Type II and Type III granites, above.

In other words an igneous origin for the Grenville granites (or for that matter, the Lewisian ones) cannot be ruled out on the basis of experimental results of doubtful applicability.

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Serpierite from Ecton, Staffordshire

SERPIERITE $(Cu,Zn,Ca)_5(SO_4)_2(OH)_6.3H_2O$, is a rare supergene mineral, known from few localities, British occurrences being confined to Ross Island, Killarney, Co. Kerry, Ireland (Russell, 1927), and the Lake District in England (Kingsbury and Hartley, 1957). We now report the occurrence of serpierite in small quantities in Clayton adit, Ecton Hill, Wetton, Staffordshire (Portal at Nat. Grid. Ref. SK096581).

The serpierite forms minute tufts of sky-blue needles on limestone, associated with gypsum and decomposing chalcopyrite. The serpierite underlies gypsum, some of which is copper stained, and crystallizes in small cracks in limestone underneath the gypsum, adjacent to a richly mineralized pocket in the adit, near the old underground engine-house. This pocket has yielded excellent specimens of aurichalcite (Braithwaite and Ryback, 1963; cf. Braithwaite and Greenland, 1963) in a friable baryte gangue, with smithsonite, hemimorphite, gypsum, and decomposing chalcopyrite in and on colourless fluorite cubes.

The identity of the serpierite was confirmed by comparison of its infra-red absorption spectrum and its X-ray diffractometer trace with those of authentic specimens of serpierite from Kamareza, Laurion (Laurium), Greece.

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