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## Cathodoluminescence of phenakite

A VARIETY of minerals are known to luminesce under electron excitation, i.e. the property of cathodoluminescence. They include calcite, dolomite, apatite, isokite, sellaite, fluorite, strontianite, zircon, wollastonite, scheelite, baddeleyite, monticellite, vesuvianite, scapolite, sodalite and feldspars (Mariano, 1978). The cathodoluminescence of minerals is used as a diagnostic tool to observe textures, to distinguish between different carbonates, different oxidation ratios of trace elements in feldspars, to recognize minerals present in small and infrequent grains and others not readily identifiable by their optical properties (Smith and Stenstrom, 1965; Mariano, 1978; Nickel, 1978; Kopp, 1981; Pierson, 1981). This contribution describes the occurrence of luminescing phenakite in samples from Late Proterozoic phlogopitized, tourmalinized metapelites which comprise the thermal aureole of Palaeozoic alkaline to peralkaline granites at Umberatana, South Australia (Lottermoser, 1986).

Cathodoluminescence studies were conducted on glass-mounted, polished thin sections in a Nuclide Corporation Luminoscope, model R ELM-2A. Observations were performed under vacuum ( $10^{-4}$  bars) at 10 kV with a current of 0.4 mA.

Specimens comprising mineral assemblages of

fluorophlogopite, tourmaline, albite, quartz, corundum, apatite, columbite usually contained several phenakite grains which gave a sky blue cathodoluminescence. A few phenakite grains lacked any signs of any luminescence. This may be interpreted as follows: Luminescing phenakite contains trace element impurities or structural defects which behave as luminescence activators, while non-luminescing phenakite is quenched by the presence of unknown ions. Absence or presence of luminescence may indicate different phenakite generations containing different impurity ions, structural defects or quenching ions.

In contrast to phenakite, beryl present within the alkaline to peralkaline granites did not luminesce under the same electron bombardment conditions. As phenakite possesses many similar optical properties under the microscope to quartz and beryl, cathodoluminescence studies can detect and distinguish minute phenakite grains from faint red, faint dull blue and white luminescing quartz as described by Long and Agrell (1965), Nickel (1978), and Kopp (1981) and from non-luminescing beryl.

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## Comments on ‘Cements in radioactive waste disposal: some mineralogical considerations’

IN explaining the Cs uptake behaviour of tobermorites, McCulloch *et al.* (1985) misquoted our paper (Komarneni *et al.*, 1982) on the cation exchange of tobermorites. These authors state on p. 217 of their paper as follows: ‘This explanation is contrary to that advanced by Komarneni *et al.* (1982) who reported that the presence of Al in the structure was essential for Cs uptake. They suggested that during the synthesis  $\text{H}_3\text{O}^+ + \text{Al}^{3+}$  substitute for  $\text{Si}^{4+}$ , subsequent Cs uptake occurring by  $\text{Cs}^+$  for  $\text{H}_3\text{O}^+$  exchange.’ We have not suggested the incorporation of  $\text{H}_3\text{O}^+ + \text{Al}^{3+}$  for  $\text{Si}^{4+}$  in our paper. In fact, Komarneni *et al.* (1982) contradicted the above substitution mechanism proposed by Kalousek (1957) and we wrote (p. 774) ‘In contrast we report here that the Al-substituted tobermorite incorporates cations other than protons within its layer structure to maintain electrical neutrality and these cations are exchangeable analogous to the smectite and vermiculite clay minerals.’

Since our 1982 paper we have published several other papers (Komarneni and Roy, 1983a; Komarneni and Roy, 1983b; Komarneni *et al.*, 1984) which more fully explain the role of a coupled

Na + Al substitution for Si in tobermorite on its alkali cation exchange and Cs selectivity properties. It is regrettable that McCulloch *et al.* overlooked the above pertinent literature. When tobermorites undergo substitution of Si by Al in the absence of alkalis, the charge must be balanced by the substitution of  $\text{Ca}^{2+}$  ions in the structure. These hydrated  $\text{Ca}^{2+}$  ions are too large to be exchanged from the interlayer positions. Thus tobermorites substituted with Al alone do not exhibit high alkali exchange and Cs selectivity (Komarneni and Roy, 1983a) for steric reasons.

Both the Al-free and Al-substituted tobermorites have similar alkali exchange only when the alkalis are not present during their synthesis (Komarneni and Roy, 1983a). The presence of alkalis in the tobermorite structure is essential for high alkali cation exchange capacity and Cs selectivity for steric reasons.

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