

DATING APOPHYLLITE FROM THE DECCAN VOLCANIC PROVINCE (INDIA)

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The Deccan Volcanic Province (DVP) formed between 67.5 and 60.5 Ma ago, but the main part of tholeiitic lava erupted within only 500,000 years or less at about 66 Ma. Originally it covered an area of approximately 1.5 million km² with a thickness of up to 3000 m. Primary cavities containing up to cm-sized idiomorphic crystals of secondary minerals are frequent in the basalts. At several locations the individual lava flows show a specific zoning with respect to the size and mineralogy of these cavities. Besides celadonite, quartz, heulandite, calcite, stilbite, mesolite, and others apophyllite is present. Apophyllite (K,Na)Ca₄Si₈O₂₀(F,OH)·8H₂O refers to a group of phyllosilicates with a chemical composition suitable for geochronological dating by the K-Ar and Rb/Sr methods. Often apophyllite is associated with stilbite, overgrowing quartz, prehnite or celadonite and locally also chalcedony filaments (probably formed by bacteria). Dated apophyllite crystals from Mumbai, Nashik, Jalgaon and Junnar are cm-sized, idiomorphic, limpid and chemically homogeneous crystals. They are characterized by distinct Rb (45 -161 ppm) and Sr (0.8 to 3.0 ppm) contents and Rb/Sr ratios of 40-860. Calculated with associated stilbite or calcite they yield ages between 20±1 and 58±1 Ma and initial ⁸⁷Sr/⁸⁶Sr ratios of 0.7068±1. However, ages determined from cavities in the same level of individual lava flows yield similar age values. Ages determined from single apophyllite crystals are reproducible with the Rb-Sr method but the maximum values of a stair step Ar-Ar age spectra are significantly lower (JAL13-K, 49±1 and 39±1 Ma respectively). Homogenization temperatures of fluid inclusions in apophyllite crystals from Jalgaon are in the range of 140-250°C.

The existing data indicate that meteoric water entered the basalts and caused hydrothermal formation of secondary minerals in cavities heterochronously between 58 and 20 Ma, dependent on the locality, the individual lava flow and position within the lava flow. Early products (e.g. quartz, celadonite, prehnite) partly formed during initial cooling but others (e.g. apophyllite, stilbite) might have also formed during later local events of increased fluid activity or reheating. According to the literature temperatures of about 80-150°C can be expected for the formation of apophyllite, stilbite and heulandite.