

The interaction of Bagh sandstone with carbonatite magma at low pressure and its mineralogical consequences: A case study from Amba Dongar, India

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In the last years, numerous studies on natural rock occurrences [1] and experiments [2] have identified contamination of carbonatitic magma by silicate host rocks as an important process in the mineralogical evolution of carbonatites. However, the major focus has been centered on granitic/syenitic and pyroxenitic host rocks/contaminants that may cause enhanced formation of mica, clinopyroxene/amphibole and/or olivine. Other mineralogically strongly deviating lithologies have so far been neglected.

Therefore, this study focuses on the interaction between carbonatite and quartz-sandstone of the lower Paleogene Amba Dongar Complex (India). Amba Dongar comprises calcitic, ankeritic and sideritic carbonatites and carbonatite breccias (with associated nephelinite and phonolite). The complex is emplaced in Bagh sandstone and partially covered by Deccan basalts. A detailed petrography of calcite carbonatite containing Bagh sandstone xenoliths indicates the contamination-related formation of wollastonite, andradite and diopside. The mineralization can be subdivided into direct black-wall reactions (wollastonite+andradite) and large-scale influences that cause mineralogical variations throughout the entire carbonatite (andradite+diopside).

Magmatic wollastonite is rarely found in carbonatites; only three occurrences are known (Alnö in Sweden, Ihouhouene in Algeria, Oldoinyo Lengai in Tanzania). Both thermodynamic modeling of the corresponding mineral assemblages and the shallow emplacement depths (<1 km) of the corresponding carbonatite complexes indicate low-pressure conditions for magmatic wollastonite formation. The absence of mica (typical for contamination in other complexes) indicates that Al is usually supplied by the contaminant, but not by the carbonatite, and that Al contamination is a critical factor for the formation of aluminum silicates in carbonatites.

Finally, both contamination-related mineral assemblages host calciobriholite (a complete apatite-britholite solid solution), which is mostly found at high temperatures (~950 °C) in experimental studies [3], while natural examples are scarce. At low temperatures, apatite and britholite (endmembers) are preferentially formed instead. Hydrothermal overprinting can lead to calciobriholite and wollastonite destabilization (britholite-apatite and calcite-quartz exsolution, respectively). Hence, preserved calciobriholite and wollastonite indicate rapid

cooling and the absence of a hydrothermal overprint.

[1] Giebel et al. (2019), *Journal of Petrology* 60, 1163-1194.

[2] Anenburg & Mavrogenes (2018), *American Journal of Science* 318, 335-366.

[3] Stepanov et al. (2023), *American Mineralogist* 108, 1043-1052.