Petrographic and mineral chemistry investigation of the high-grade chrysotile asbestos-bearing Zvishavane Ultramafic Complex, south central Zimbabwe

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Abstract

The Zvishavane Ultramafic Complex (ZUC) in the south central part of the Zimbabwe craton is comprised of coarse-grained serpentinites, metadunites and metagabbros and hosts Africa's largest reserves, and largest mine, of high-grade chrysotile asbestos. Magnesiohornblende, actinolite, plagioclase (An0.6–41.9), augite, diopside and clinozoisite constitute the mineralogy of the ZUC. Forsteritic olivine (>Fo90) was altered to form chrysotile and antigorite minerals, although some primary olivines are preserved. Contents of Al2O3 range from <1 to >2.5 wt% at TiO2 values of <0.7 wt% consistent with an island arc setting for the ZUC that originated from tholeiitic magmas. The Zvishavane Ultramafic Complex was metamorphosed at relatively high temperatures (542-779 °C) and low pressures (1.2-2kbars), consistent with contact metamorphism. Intrusion of several granitic batholiths relatively close to the ZUC likely triggered hydrothermal fluid migration which metamorphosed the ZUC. The associated asbestos deposits likely formed during hydrothermal circulation events. Zoned amphiboles, the occurrence of magnesiohornblende and actinolite, as well as cross-cutting serpentine veins are consistent with at least two stages of alteration and/or metamorphism of the ZUC. The lack of a thrust contact between the ZUC and its country rocks is consistent with the ZUC having intruded into the host Zvishavane Gneiss Complex and possibly acted as a feeder to the nearby Mberengwa greenstone belt (MGB). However, the occurrence of near end-member forsteritic olivine, the presence of zoned amphiboles, and faulting within the ZUC are all suggestive of an ophiolitic origin although forsteritic olivines also occur in intrusive layered complexes. Metamorphism of the ZUC, ascribed to intrusion of multiple batholiths and possibly the MGB, likely led to the formation of ZUC chrysotile asbestos deposits.

Keywords: Ultramafic complex,Petrography, Mineral chemistry Thermobarometry