Variole bearing pillow lavas of the ~3.5 Ga Mount Ada Basalt, East Pilbara Terrane, formed through liquid immiscibility of a water saturated magma

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Melting regimes that can be inferred from volcanic rocks preserved in Archean greenstone belts provide constraints on the geodynamic environment in which early crust formed. Variole bearing lavas that are common in Archean greenstone belts have received minor attention for their geodynamic implications. Here we present petrological, geochemical and ^{147}Sm-^{143}Nd isotope results from variole bearing Mount Ada Basalt samples from the Doolena Gap and Warralong greenstone belts of the East Pilbara Terrane. The samples have undergone lower greenschist facies metamorphism but with preserved magmatic texture, clinopyroxene and spinel. No plagioclase or spherulite crystallisation textures are present. Pyroxene and spinel chemistry is identical between variole and dark host. The varioles have low MgO (2-6 wt%) and low Fe_2O_3total (3-7 wt%) in contrast to the dark host material with high MgO (8-12 wt%) and high Fe_2O_3 total (13-19 wt%). Elements such as Ti and Cr are indistinguishable between the variolitic and dark host material. All samples have low Nb/Th (2-7). Combined samples from the two greenstone belt give an errorchron Sm-Nd age of 3484 ± 190 Ma. There is no difference in initial εNd between variole and meanocratic material. The initial εNd of Warralong samples range from 0.98 to -0.19 while the inital εNd of Doolena Gap samples range from -0.02 to -1.34.

Petrographic results preclude magma mingling or supercooling for the formation of the variole texture. We propose that the variole texture is the result of water saturation driven liquid immiscibility. If correct, this indicates that the variole bearing lavas represent the surface expression of hydrous fluxed mantle melting. The Mt Ada Basalt is coeval with the Callina granitic supersuite that has been interpreted to result from melts of mafic crust dripping into the mantle as a Raleigh-Taylor instability. Dehydration of this mafic material in the upper mantle could be the source of the hydrous flux.