

Archean Hyaloclastites: Fragmentation Process and Composition of the 2.72 Ga Stoughton-Roquemaure Komatiites-Komatiitic Basalts

J Dostal (Department of Geology, Saint Mary's University, Halifax, Nova Scotia, Canada B3H 3C3; ph. 902-420-5747; fax: 902-420-5261; e-mail jarda.dostal@stmarys.ca); W U Mueller (Sciences de la terre, Université du Québec à Chicoutimi, Chicoutimi, Québec, G7H 2B1; ph. 418-545-5013; fax: 418-545-5012; e-mail wmueller@uqac.quebec.ca)

The 0.2-2 km-thick Stoughton Roquemaure Group (SRG) of the Abitibi greenstone belt is part of mafic-ultramafic volcanic cycle which formed part of the early Abitibi ocean floor. The volcanic flows of the SRG are novel in that this sequence flooded the deep-water, felsic-dominated, 2,725-2,733 Ma Hunter Mine caldera, so that segments may well represent deep-water oceanic plateaus. The significance of these high temperature (1400-1600°C), low-viscosity flows in the SRG study area is two-fold: 1) ultramafic hyaloclastites formed between pillows and master tubes, and 2) Al-depleted ($\text{Al}_2\text{O}_3/\text{TiO}_2 \sim 10$) and Al-undepleted ($\text{Al}_2\text{O}_3/\text{TiO}_2 \sim 20$) komatiitic flows occur in the same outcrop zone. The Al-depleted komatiites have fractionated heavy REE patterns due to the presence of garnet in the residue after mantle melting. The Al-undepleted Munro-type komatiites with chondritic $\text{Al}_2\text{O}_3/\text{TiO}_2$ have unfractionated flat heavy REE patterns possibly due to high degrees of melting leaving only olivine+/- orthopyroxene in the residue. Alternatively, the Al-undepleted komatiites could have been generated by melting of a garnet-free source, probably at shallower depth.

The SRG, composed of two 50-400 m-thick komatiitic units alternating with 100-1000 m-thick basalt flows, was subjected to only subgreenschist metamorphism, enabling preservation of primary volcanic textures and 3-D flow-surface features. Volcanic facies architecture shows (1) complex master tubes, >20m wide, (2) secondary distributary tubes, 5-20 m wide, (3) branching pillows and pillow tubes <5 m wide, (4a) pillow fragment breccia, and (4b) hyaloclastite and pillow rind breccia. Eruptive cycles, 50-150 m-thick, are suggestive of pulsating magma supply. Hyaloclastite development in komatiites worldwide is rare, and especially so at depth. Structureless, poorly sorted, hyaloclastite beds, 0.20-4 m-thick, formed adjacent to distributary tubes, pillowed tubes with multiple rinds, or pillow fragment breccia. The cm-to mm-scale, non- to poorly vesiculated hyaloclasts are blocky (angular) to wispy-shaped and contain pyroxene microlites and phenocrysts (\pm olivine) in chlorite matrix (initially glass). Vesicles locally represent fragment and shard boundaries. Thermal contraction generally causes fragmentation, but considering the high extrusion temperatures and the low-viscosity of komatiites, as well as high hydrostatic pressures, implosions and surface explosions may also have occurred. The

exceptionally low viscosity of komatiites should facilitate magma-water mixing, and hence interaction. Seawater entrained into komatiite flows or ingested into flow fractures will have the fuel-coolant effect, whereby after initial explosive expansion, the hydrostatic pressure subdued the explosion causing instantaneous collapse, but not before fragmentation and pillow tube disintegration was achieved. The combination of blocky clasts and magma wisps support a fuel-coolant process because after fragmentation of solidified crust occurred, magma interacted with water producing wispy-shaped glass fragments. Fragmentation occurs in slower moving pillowed flows which allows for ingestion of water along cooling fractures. This facilitates explosive expansion and implosion to occur. Although such a mechanism is minor, it does represent a hydroclastic fragmentation mechanism at depth.