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Fred's Flow (Canada) and Murphy Well (Australia): thick komatiitic lava flows with contrasting compositions, emplacement mechanisms and water contents

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Two Archaean komatiitic flows, Fred's Flow in Canada and the Murphy Well flow in Australia, have similar thicknesses (120 m and 160 m) but very different compositions and internal structures. Fred's Flow is the type example of a thick komatiitic basaltic flow. It is strongly differentiated and consists of a succession of layers with contrasting textures and compositions. The layering is readily explained by the accumulation of olivine and pyroxene in a lower cumulate layer and by evolution of the liquid composition during downward growth of spinifex-textured rocks within the upper crust. A parental liquid was constrained to contain ca. 18 wt% MgO and ca. 5 to 35%vol phenocrysts and it differentiated into cumulates containing 45 wt% MgO and a residual gabbroic layer with only 6 wt% MgO.

The Murphy Well flow, in contrast, has a remarkably uniform composition throughout. It comprises two layers, a 20-m-thick upper layer composed of fine-grained dendritic olivine and 2-10% amygdales, a 120-m-thick lower layer of olivine porphyry, and a lowermost 20 m of olivine orthocumulate. Throughout the flow, MgO contents vary little, from only 30 to 34 wt%, except for the slightly more magnesian basal layer (35-40 wt%). The uniform composition and dendritic olivine habits suggest rapid cooling of a highly magnesian liquid with a composition like that of the bulk of the flow. Under equilibrium conditions this liquid should have crystallized olivine with the composition Fo95.5 but the most magnesian composition measured by electron microprobe in samples from the flow is Fo93. To explain these features, we propose that the original liquid was hydrous and contained around 32% MgO. It degassed during eruption creating a supercooled liquid that solidified quickly and crystallized olivine with non-equilibrium compositions. To account for the 60-70vol% olivine throughout the flow requires a combination of degassing and cooling by the evacuation of heat in the escaping fluid.