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Geochemical Architecture of the Golden Valley Sill Complex, South Africa: Implication for Saucer-Shaped Sill Emplacement in Sedimetary Basins

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The Golden Valley Sill Complex (GVSC) in the Karoo basin has been used as basis for a detailed study of saucer-shaped sill complexes aiming to develop new models for magma emplacement mechanisms in sedimentary basins. This study, based on detailed mapping and sampling of the GVSC, concerns more specifically the feeding processes of a nested sill complex by focusing on the geochemistry of the various magma batches and their spatial distribution in the GVSC.

Major and trace elements were analyzed on 374 samples from 5 saucer-shaped sills and two dykes. The magmas have a rather evolved but uniform tholeiitic composition (basalt to basaltic-andesite; 3.7-8.8 wt% MgO) indicating that the GVSC magmas are not primitive melts. Geochemical data show fractional crystallization trends and suggest some crustal contamination. These differentiation processes have taken place on the way from the mantle source region to the surface. A statistical approach (Forward-Step Discriminant Function Analysis) has been applied on the geochemical data-set of the GVSC in order to isolate groups of samples of similar geochemical signatures. This analysis indicates that the Golden Valley nested sill complex formed from four magma batches, each with a distinct geochemical composition. Three saucer-shaped sills, as well as a dyke, formed from a single batch of magma. This indicates that dykes feed saucer-shaped sill. The identification of identical chemical composition within two connected saucer-shaped sills also indicates that saucers feed each other to form a nested-sill. The other saucer-shaped sills and the dyke represent distinct magma batches. The GVSC thus formed partly by different magma batches feeding separate

saucer-shaped sills, partly by saucer-shaped sills feeding new saucer-shaped sills.

These successive episodes of magma injections occurred over a short geological time. The heating processes (single or repeated) of given volume of sedimentary rocks is an important factor for the degree of hydrocarbon maturation in sedimentary basin.