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## Discovery and significance of komatiite: 50th Anniversary

In July 1969, 50 years ago, the discovery in the Barberton area of a new type of ancient volcanic rock was announced in Pretoria at an international geological symposium.

The discovery of this new rock, which was called komatiite, stemmed from extensive research carried out as part of an international cooperative programme to study the nature of the earth's upper mantle, lying below the earth's crust. One of the six projects identified for study was that of ultrabasic rocks (rocks with ultra-high magnesium content) approaching the composition of the earth's upper mantle. In 1965, we were appointed to carry out PhD studies in the Department of Geology at the University of the Witwatersrand on a range of ultrabasic rocks which were known to occur in the lower part of the 3.5-billion-year-old Barberton Greenstone Belt. These rocks had previously been ascribed to a deep-seated intrusive igneous suite, similar to the well-known Bushveld Igneous Complex. At this time, no conclusive evidence had been found of ultrabasic magma extruded on the surface of the earth as lava flows.

However, our extensive, detailed, geological mapping over four field seasons provided, for the first time, unequivocal evidence for the widespread presence of ultrabasic lava flows in the well-preserved, lowermost formations of the Barberton Belt in the Komati River Valley. Evidence included the recognition of extensive successions of pillowed basaltic lava (indicative of sub-aqueous extrusion) with unusually high magnesium contents. Interlayered with these lava flows were ultrabasic rock sequences with features suggesting that they too were of volcanic origin.

The ultrabasic rock sequences were found to be composed of discrete thin units with fine-grained chilled contacts indicative of rapid cooling of magma at the surface. In addition, the presence of a distinctive spiky texture (later called 'spinifex texture') was found to be present in the upper part of the thin ultrabasic units. This texture was shown to be a rapid supercooling feature of the ultrabasic units which were later confirmed to be ultrabasic lava flows. The presence of cross-cutting intrusive ultrabasic, 'feeder' dykes, was also evidence for the existence of an ultrabasic magma.



Bladed 'spinifex' textured crystals of olivine passing upwards into random or 'bird track' spinifex in a komatiite lava flow. These delicate crystal structures, the result of supercooling of an ultrabasic lava flow, are now recognised as one of the iconic and diagnostic textures in geology.

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The twin brothers, geologists Richard and Morris Viljoen.

An extensive literature search revealed that the geochemistry of these olivine-rich ultrabasic rocks was distinctive, and that they had no similarity to any known class of lava or ultrabasic rock previously described on our planet. Some unique features of the Barberton ultrabasic lavas included a high magnesium content (averaging 28% MgO), low aluminium and very low potassium and sodium content, together with a high calcium-to-aluminium ratio. Based on all the above evidence, a new class of high temperature, ultrabasic volcanic rock was proposed, and the name 'komatiite', after the Komati River, was introduced by us. The associated magnesium-rich basalts were also shown to be unique and to have close affinities with the ultrabasic komatiite lavas. They were termed 'basaltic komatiite' (now called komatiitic basalt).<sup>1,2</sup>

Numerous renowned geoscientists contributed to the recognition of komatiite. Among them was Professor Harry Hess of Princeton University, a world authority on ultrabasic rocks, who visited the outcrops of the ultrabasic lava flows prior to attending the upper mantle symposium in Pretoria in 1969. He fully endorsed the evidence presented for introducing komatiite as a major new class of ultra-high temperature volcanic rock. Komatiites are now part of the vernacular of geology, on a par with, and completing, the long-standing volcanic rock classification sequence of rhyolite, andesite, basalt, and now komatiite.

Soon after the Barberton discovery, komatiites were recognised and described from many other Archaean greenstone belts worldwide, and were described by Arndt and Nisbet in 1982 as 'one of the most important petrological advances of this century'<sup>3</sup>. Experimental melting and supercooling of komatiite lavas has shown that they were extruded in a primordial ocean at temperatures of more than 1600 °C. This is far hotter than the temperature of extrusion of oceanic lavas such as those from Hawaii which erupt at temperatures of about 1250 °C. It has further been shown that komatiite lavas represent an almost total melt of the earth's

upper mantle. They formed the earth's earliest oceanic crust before the widespread intrusion into the primordial komatiitic crust of the major continent-forming granitic rocks which are also classically exposed in the Barberton region.

Of great significance is the fact that 3.47-billion-year-old carbonaceous sediments, in places interlayered with komatiites, contain the earliest forms of life known on our planet. These life forms occur as biomats and resemble present-day algae and cyanobacteria. The link between them and the nutrient-enriched environment supplied by the komatiite lavas is compelling. A close genetic relationship between gold mineralisation in greenstone belts and, in particular, the Barberton Belt and komatiites, has also been shown to exist and exciting new concepts are developing.

Research on komatiites continues unabated and there are now hundreds of publications on these fascinating rocks. We gave talks at the University of the Witwatersrand to mark the 50th anniversary of komatiites, and, in September 2019, we led a 4-day excursion to the Barberton area. A popular style geoheritage guidebook to the region is also being prepared and will be published by the Geological Society of South Africa.

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