

**FIELD STUDIES OF BRONZITE GRANOPHYRE, VREDEFORT STRUCTURE, SOUTH AFRICA;** A.M. Theriault<sup>1</sup> and W.U. Reimold.<sup>2</sup> <sup>1</sup>Department of Geosciences, University of Houston, Houston, TX, 77204; <sup>2</sup>EGRU/Department of Geology, University of the Witwatersrand, P.O. WITS 2050, Johannesburg, South Africa.

In recent years increased interest has been shown in the bronzite granophyre (BG) that occurs as a series of homogeneous dikes in the Vredefort structure, South Africa.<sup>1,2,3,4</sup> These recent studies, most of which rely heavily on earlier field work,<sup>5,6</sup> reach contrasting conclusions as to the origin of the BG. During the summer of 1990, a field study of the BG was completed for all the exposed dikes. The objectives of this study were: (1) to describe the field relations between BG and host rocks, (2) to determine the attitude of BG dikes, (3) to describe the matrix texture and clast distribution for all BG dikes, (4) to sample each dike systematically, both along and across strike, and (5) to sample the numerous clasts found in BG dikes. The field observations are presented herein.

**The BG Dikes:** The BG is medium gray to dark greenish-gray on fresh surface, and rusty medium brown to dark brown on weathered surfaces. The surface of the dikes may be pitted to different degrees due to erosion and differential weathering of and around the clasts. Vesicles are also common in all dikes. Ten BG dikes extending for a total of approximately 50 km can be mapped within the Vredefort structure. BG dikes occur in two major zones: five dikes occur in the northwestern and western parts of the core near the town of Vredefort, and five others occur at the core-collar boundary, forming a crescent from the north-northeastern part to the western part of the ring. The BG in the core of the structure (zone 1) occurs as small radiating dikes, up to 20 m wide and 4.5 km long. At the core-collar boundary (zone 2), the BG occurs as much larger dikes, up to 65 m wide and 9 km long, concentric to the structure. At the ground surface in zone 1, the dikes are exposed as discontinuous, sinuous, and even kinked lines of sparsely distributed rocks. More massive and positive outcrops occur in zone 2, but the dikes remain discontinuous and sinuous. Offshoot arms to the main dikes, occurring in both zones, are rare and vary in size (a few meters wide and a few to tens of meters long). At the ground surface, the dikes terminate in two fashions: by pinching out, or by sharply ending at a slope or before a depression such as a valley or dry creek. Five sets of joints are observed: horizontal; vertical, perpendicular to the walls of the dike; vertical, parallel to the strike; oblique, perpendicular to the walls of the dikes; and oblique, dipping in the direction of strike. These joint sets occur together with one being the most dominant, depending on the location. Displacements up to a few decimeters were observed along some of these sets. Faulting has been observed to affect the BG dikes at some localities.

**Magnetometry Survey:** A magnetometry survey, using an EGS magnetometer mounted on a vertical rod, was carried out over four of these dikes (two located in zone 1 and two in zone 2). The purposes were to determine (1) if the magnetic signature of BG can be used to trace the dikes, (2) if BG dikes are truly continuous or discontinuous, and (3) if they dip at depth. Although dip angles have not yet been computed, the survey nevertheless has yielded interesting results. The signature difference between BG dikes and host rocks is strong (~700nT) in zone 2 and weaker (~300nT) in zone 1. In addition, the magnetometer can be used to confirm the presence or absence of dikes in at least two cases: (1) the subsurface (and often sinuous) continuity of dikes that "disappear" can be confirmed magnetically; and (2) the presence of the dikes that "disappear" into the depressions cannot be detected magnetically, suggesting that at such localities the BG terminates, has been eroded away (at least to some depth), or is interrupted by a fault zone (indicated in some cases by displacement of the dike on the other side of the depression).

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**Contacts and Crosscutting Relationships:** Crosscutting relationships are generally clear, with the BG intruding the country rocks. In general, contacts have been eroded, and only one true contact was observed in Zone 1, where the host rock is a charnockite. At one locality in Zone 2, where a trench is cut along the flank of one dike, the outer (~4-meter thick) edge of the dike is strongly jointed and easily eroded and displaced. Another plausible agent causing the destruction of contacts would be reactivation of fault lines, a phenomenon suggested by slickensides observed on some contact surfaces. In places where massive outcrops of both BG and host rocks occur close together, fractures, joints, and color changes are observed in the host closest to the BG dike. In a few localities throughout the structure, pseudotachylite occurs on both dike margins between BG and the granite host. It is unclear whether the pseudotachylite pre- or post-dates the BG or if they are contemporaneous. Pseudotachylite veins crosscutting the country rocks are common, however no pseudotachylite or other rock types have been recognized to cut the BG.

**Clasts and Matrix:** The BG is composed of orthopyroxene, plagioclase, alkali feldspar and quartz as major phases, ilmenite, magnetite, apatite and zircon as minor phases, and numerous, accessory monomineralic and lithic fragments. The larger clasts (2 - 80 cm in diameter) tend to be concentrated on one side of any given dike. Fractures were seen to cut both the clasts and the matrix. The clasts are subparallel and stretched, or folded and curved, or fractured and faulted. The major country rocks are all represented as clasts in every dike examined. Granite, gneiss and quartzite are the most abundant, shale and metasediments other than quartzite are less abundant, and mafic clasts are rare. Although apparent shock features have been observed in the adjacent rocks,<sup>7</sup> none have been found in the clasts included in the BG dikes. In zone 1 the matrix is characterized by spherulitic textures, with spherules ranging from less than 1 cm up to 4 cm in diameter. In zone 2 the matrix is more granular and fine-grained, lacks spherulitic textures, and shows what appear to be "flow textures" at the rock surface.

**Discussion:** The BG is extremely homogeneous in bulk chemical composition on a regional scale.<sup>4</sup> The clast distribution is virtually the same in all dikes. There are, however, definite textural and dimensional distinctions between the BG dikes of the core zone and those of the core-collar boundary. The BG in the core must have cooled more rapidly than at the core-collar boundary where dike size may be constrained by the fracture system available at the time of emplacement. These observations are not sufficient to determine an impact or cryptoexplosion origin for the BG. Further studies are underway on: (1) petrography of the samples collected, including a search of shock metamorphism in clasts; (2) mineralogical and geochemical analyses with respect to major- and trace-element compositions, to establish whether variations exist in bulk composition or mineral composition within and between dikes; (3) assessment of temperatures using ilmenite-magnetite geothermometry; and (4) palaeomagnetic analyses to complete the magnetic data and determine the dip angles of the BG dikes.

**References.** (1) Bisschoff, A.A. (1988) *S.Afr.J.Sci.*, 84, 413-17. (2) French, B.M. and Nielsen, R.L. (1988) *LPSC XIX*, 354-55. (3) French, B.M. et al. (1989) *Proc. 19th Lun. Plan. Sci. Conf.*, 733-44. (4) Reimold, W.U. et al. (1990), *Proc. 20th Lun. Plan. Sci. Conf.*, 433-50. (5) Hall, A.L. and Molengraaff, G.A.F. (1925) *Verhand. Akad. Wer. Amst.*, 2 sec, Deel 24, 3, 1-183. (6) Nel, L.T. (1927) *Geol. Sur. S. Afr.*, Spec. Publ. 6, 133pp. (7) Grieve, R.A.F., et al. (1990) *Tectonophys.*, 171, 185-200.