NERC GEF Report (Loan 894, Leica 1200 GPS)

Mapping the Igwisi Hills kimberlite volcanoes, Tanzania: understanding how deep-sourced mantle magmas behave at the Earth`s surface

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Abstract
The Igwisi Hills volcanoes, Tanzania, are the youngest and best-preserved kimberlite volcanoes on Earth. Uniquely they preserve the surface deposits and constructs, which are absent at all other kimberlite volcanoes. They provide an unparalleled opportunity to investigate the eruptive dynamics of ultrabasic kimberlite magmas. The volcanoes are situated in a remote part of western Tanzania and detailed topographic maps and high resolution aerial photography do not exist. As part of a detailed field study of the volcanoes, a Leica 1200 differential GPS, loaned from GEF, was used to undertake a high resolution topographic survey of the Igwisi Hills volcanoes. RTK continuous GPS surveying of the volcanoes and their surrounds captured the morphology of the volcanoes and provided the base for the first detailed geological map of these unique edifices. The field study revealed important new insights into kimberlite volcanism, including the presence of viscous kimberlite lava flows (e.g., a lava coulee) and kimberlite cinder cones. The detailed GPS survey captured primary morphological features pertinent to understanding the nature of the eruptions and will help to constrain the volume of the volcanic constructs and the erupted products.

Background
Eruptions of ultrabasic magmas have not been witnessed by mankind, and the dynamics of their ascent, degassing or dispersal as pyroclasts or lavas at the surface are not well constrained (see Sparks et al., 2006). Kimberlites belong to a suite of ultramafic magmas that includes carbonatites and lamproites, and are characterised by inferred very low silica contents, high volatile contents and low magmatic viscosities (Mitchell, 1986). They derive from great depths (> 150 km) and entrain host rock from the mantle upwards during ascent. Despite their apparent abundance in the geological record (> 3000 known occurrences) kimberlite eruptions have been exceptionally sparse since the Middle Eocene (*ca*. 40 Ma; Kjarsgaard, 2007). Due to their great age most kimberlites have long had their surface deposits removed by erosion. All that remains for study are the deposits and intrusions preserved within their volcanic vents (kimberlite pipes). Volcaniclastic rocks preserved within these vents have proved problematic to interpret and a number of different, but not mutually exclusive, processes have been proposed and elaborated, including fluidisation (Dawson 1971; Field and Scott Smith, 1999; Sparks et al, 2006; Walters et al., 2006; Gernon et al., 2008a and b), phreatomagmatism (Lorenz, 1975; Lorenz and Kurslaukis, 2007; Kurszlaukis and Lorenz 2008; Ross and White, 2006), eruption column collapse (Porritt and Cas, 2008) and re-sedimentation (Moss et al., 2008).

Outputs to date

Conference presentations

Brown RJ, Manya S, Field M, Fontana G, Sparks, RSJ, 2010. The Igwisi Hills volcanoes, Tanzania: superbly exposed examples of young kimberlite volcanism. Volcanic and Magmatic Studies Group, Glasgow, 4-6th January.

Manuscripts

Brown R.J., Manya S., Field M., Sparks R.S.J., Fontana G., in prep. The eruption of the Igwisi Hills Volcanoes, Tanzania: constraints on kimberlite volcanism from surface deposits. Bulletin of Volcanology.

Brown R.J., Manya S., Field M., Sparks R.S.J., Fontana G., in prep. The dynamics of explosive and effusive eruptions from kimberlite volcanoes: insights from the volcanic products of the Igwisi Hills volcanoes, Tanzania. Bulletin of Volcanology.

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