Preferential distribution along transcontinental corridors of kimberlites and related rocks of Southern Africa

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ABSTRACT

Regional and local structural controls on the emplacement of 1326 Southern African kimberlites and related rocks (kimberlites sensu lato, 11% of which are dated) are analysed using a framework of lineaments defined by combining geology, aeromagnetics, gravity and geomorphological data. Spatial analysis of occurrences within clusters of kimberlites less than 100km across resolves variable trends, depending on the age and position of the cluster; but on a regional scale the distribution of these clusters is statistically controlled by four lineament trends: 040°, 096°, 134° and 165°. Similar regional trends are observed as aspect lineaments that can be followed over large distances from modelling the variation in dip direction of the Southern African topography. These observations suggest that different geological parameters exert a control on the distribution of kimberlites. Local structures may include en-echelon fault arrays, Riedel, R'-, P- or T-structures within trans-continental lithosphere structures (cryptic continental corridors). Many cryptic continental corridors are collinear with fracture zones along the Atlantic and Indian continental margins of Southern Africa, and may have found their origin in events resulting from plate reorganization during the break-up of the supercontinent Gondwana. Fault resistance may have rapidly changed the stress state of the African continent causing the deep lithospheric faults to be the loci of episodic extension, allowing kimberlite fluids to ascend through the faults and cluster within near-surface structures. A progressive age variation of kimberlite magmatism in Southern Africa may be attributed to stress propagation along deep lithospheric fractures.

Introduction

According to Visser (1998), "the complexity of the distribution of kimberlites (in South Africa), their age and petrology do not fit any structural lineaments of alkaline activity, as is the case in Namibia, or any predicted hot-spot track." Yet spatial relationships to lineaments and hot spots have frequently been cited in the literature (*e.g.*, Le Roex, 1986; Skinner, 1989). We analyse the coincidence between 1326 kimberlite occurrences in Southern Africa in relation to regional geological and geophysical data, to examine these claims.

Kimberlites and related rocks (hereafter referred to as kimberlites in the broad sense of the word) of Southern Africa range in age from the Palaeoproterozoic to the Cenozoic and originate deep in the mantle lithosphere (*e.g.*, Skinner *et al.*, 1992; Gurney, 1992; unpublished data, de Beers). They include potentially diamondiferous rocks such as kimberlites (Group I), orangeites (micaceous Group II kimberlites), olivine lamproites and superficially similar but uneconomic rocks such as melnoites (ultramafic lamprophyre or melilitite), alnoites, as well as a variety of mafic phonolites and carbonatites (*e.g.*, Mitchell, 1995), that have a common origin within the upper mantle (Harmer, 1998; Mitchell, 1986). Amongst these, the diamondiferous members are generally restricted to Archaean crust (modified Clifford's Rule; Clifford, 1966; Janse, 1991), underlain by thick continental lithosphere mostly also of Archaean age (Pearson, 1999; Shirey *et al.*, 2004). Archaean crust in Southern Africa comprises the