## *THE PROTEROZOIC: ITS ROLE IN DIAMOND PETROGENESIS AND THE EMPLACEMENT OF MANTLE DERIVED INTRUSIVES*

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The search for diamondiferous intrusive rocks has again gained momentum in the 1990's with new finds in Canada, renewed interest in Africa and India, increased activity in Australia and on going interest in countries such as Brazil and Russia. Though the majority of diamond mines are located on ancient cratonic blocks(>2500 Ma), a large number of diamondiferous intrusives, including kimberlites and lamproites, are found in off-craton settings underlain by younger Proterozoic rocks

In view of their durability, diamonds may be found in many settings, particularly in environments where sedimentological, glacial and allied processes have contributed to their presence and in some cases the 'upgrading' of secondary deposits. These 'localities' are often substantially removed both in time and space from likely source areas. Prospecting commonly focuses on such diamond bearing areas and there is also a tendency to turn attention to often associated mantle derived rocks as the likely source of these diamonds.

Diamond bearing kimberlites and lamproites found in Proterozoic basement settings have in recent years attracted considerable exploration interest and large numbers have been found. Examples of such primary intrusives with diamonds, in greater and lesser abundance's, include the following for predominantly kimberlite host rocks: Fort a la Corne (Canada), Upper Michigan Peninsula and State Line District (USA), Rondonia, Mato Grosso and Minas Gerais (Brazil), Ghana (?)(West Africa), Bushmanland (South Africa), South Australia, Northern Terroritories and the Kimberleys (?)(Australia). For lamproites, examples include Prairie Creek (USA), Kapamba in Zambia (East Africa), Bobi/Sequela in the Ivory Coast (West Africa), Argyle and Ellendale (Australia), and rocks referred to as lamproites in Southern China.

Other examples no doubt exist and details pertaining to the exact nature of the basement and tectonic setting of some of these examples is subject to debate and uncertainty. The key issue however is that these and other localities contain diamonds, have in most cases been or are the focus of exploration activity, and in some cases have produced diamonds on an irregular or reasonably sustainable basis. Importantly however, with the exception of Argyle, these localities host no major primary mines, and their overall contribution to the world diamond trade in terms of value is relatively small. A general observation is that diamonds found in such localities are of somewhat poor quality and grades are low, though there are obvious exceptions to this, e.g. Ellendale - high quality, low grade, and Argyle - poor quality, very high grade. In a number of the examples listed above most production is from alluvial deposits which are often closely associated with supposed source rocks e.g. Brazil.

In the past the presence of localities such as those listed above was explained by recourse to special tectonic circumstances, e.g. thrusting of Proterozoic rocks over Archean basement and complex mantle plumbing arrangements. Though the former tectonic arguments may apply to some examples, the extent and number of these localities warrants detailed analysis and explanation. A further critical point is that isotopic studies of diamond inclusions point to a wide spectrum of Proterozoic diamond formation ages, and studies of diamond inclusions from off-craton sources, though limited in number, indicate sampling of mantle that is not that dissimilar to that reflected by diamond inclusions sourced from cratonic settings.

Considering the available information it is argued that kimberlites found in Proterozoic basement settings, often in large numbers covering extensive areas (possibly more so than on cratonic domains) are diamondiferous as a consequence of the sampling of underlying mantle source rocks that contained diamonds and that models such as tectonic overthrusting need not apply. A further implication is that the Proterozoic was an important period for diamond formation in the earth's mantle, both in cratonic and adjacent newly formed or reworked Proterozoic terranes. The exact processes of diamond formation is unclear though subduction and other processes dissimilar to Archean processes were probably important.

Proterozoic mantle 'source' rocks are on the basis of present information probably sparse in volume and poorly developed and may have been prone to considerably more diamond destruction than would possibly be the case in stable cratonic settings. Processes such as magmatism and metasomatism are likely to have been more regular and prevalent in such settings thereby effectively destroying part of the diamond budget that may have formed in such settings. It is also unlikely that stable mantle domains as implied below Proterozoic settings would have been resident in the diamond stability field for long periods of time. Consequently opportunities to form diamonds may have been restricted, and the opportunity of destroying diamonds high.

In formulating target selection and exploration programmes for diamonds it is important to fully asses the tectonic settings and their potential yield in terms of diamondiferous source rocks. Primary diamondiferous rocks are found in cratonic and Proterozoic settings, though an overriding fact is that all currently active large and small diamond mines are, with the exception of Argyle, are located on cratons with basement older than 2500 Ma. Many diamonds were however formed by Proterozoic processes, and Proterozoic (and younger) orogenic events probably played a key role in the emplacement of mantle derived rocks, including those carrying diamonds.