KIMBERLITES AND LAMPROITES COMPARED AND CONTRASTED

Barbara H. Scott Smith

2555 Edgemont Boulevard, North Vancouver, B.C., Canada V7R 2M9

INTRODUCTION

Kimberlite was the term coined in the late 19th century to describe the host rock of diamond at the type locality, Kimberley, South Africa (Lewis 1887, 1888). Innumerable kimberlites are now known worldwide; some of them contain economic quantities of diamond while others are barren. Kimberlite was considered to be the only important primary source of diamond for about a century while lamproites were thought only to be academic curiosities. In the late 1970's prospecting in north Western Australia lead to the discovery of some diamondiderous pipes which were subsequently recognised as lamproites (Atkinson et al. 1984; Jaques et al. 1984, 1986). Of these, the Argyle pipe, is now the richest known primary diamond deposit in terms of grade (Madigan 1983; Boxer et al. 1989). At present, only relatively few lamproites are known worldwide (Mitchell and Bergman 1991). Two of these are Majhgawan and Hinota in India (Fig. 1).

Only during the last two decades, therefore, has it been recognised that lamproites are a second primary source of diamond. The first primary deposits of diamond are generally considered to be those found in South Africa during the 1860's. Although by 1872 it was known that these deposits were not alluvial, it was not until the late 1880's that they were first realised to be volcanic breccias (Lewis 1887) and then defined as kimberlite (Lewis 1888). More information is given in the review presented by Mitchell (1986 - Chapter 1). The Majhgawan pipe in India was discovered before the South African occurrences and, although not recognised as such then, it is actually the first primary source of diamond to be found. Majhgawan was found by diggers before 1827 when it was known to be different from the nearby secondary deposits (Halder and Ghosh 1974) but only later was it shown to be a volcanic pipe (Sinor 1930). Interestingly, the diamondiferous pipe at Prairie Creek in Arkansas was found in 1842 (cited by Branner and Bracket), again before the South Africa pipes. This shows that the first two primary sources of diamond to be discovered are lamproites rather than kimberlites!

Various aspects of the geology of kimberlites and lamproites are briefly outlined here to show that they are distinctly different rock types. The implications of these difference are then discussed, with an emphasis on petrogrpahy and India. This short paper largely comprises extracts from Scott Smith (1989; in press). Recent detailed reviews of the nature of kimberlites and lamproites are given by Mitchell (1986) and Mitchell and Bergman (1991) respectively. Other useful reviews are Mitchell (1991) and Geological Survey of Canada (GSC) open file report (1989).

KIMBERLITES

Kimberlites are complex hybrid rocks typically containing mantle-derived xenoliths and xenocrysts and a range of primary phases crystallising from a kimberlite magma which may itself be derived from several mantle sources. Kimberlites also often contain abundant crustal derived material. During the last two decades considerable effort has been expended in investigating these rocks. They are now relatively well understood.

Definition : This brief definition is modified after Clement et al. (1984) and Mitchell (1986, 1989). "Kimberlites are a clan of volatile-rich (CO_2 and H_2O), potassic, ultrabasic rocks. They exhibit a distinctive inequigranular texture resulting from the presence of macrocrysts (and in some instances megacrysts) set in a finer grained matrix. The macrocryst assemblage consists of anhedral grains which are dominated by olivine but include phlogopite, magnesian ilmenite, chromian spinel, magnesian garnet, clinopyroxene and orthopyroxene. The matrix contains phenocrysts of olivine and in some instances phlogopite, together with several of the following groundmass minerals : phlogopite, carbonate (typically calcite), serpentine (commonly Fe-rich), clinopyroxene (typically Al- Ti-poor diopside), monticellite, apatite, spinels (Ti-, Mg-chromite), perovskite and ilmenite. Alteration of macrocrysts and some matrix minerals by deuteric processes, typically serpentinisation and carbonatisation, is common."

Mineralogical classification : Kimberlites are classified mineralogically using the modal abundances of the main primary groundmass minerals (after Skinner and Clement 1979). A kimberlite thus may be described as a "diopside phlogopite kimberlite". Xenocrystal and phenocrystal olivine are ignored as they are ubiquitous. This classification is best applied to hypabyssal kimberlites and is useful in comparing kimberlites within and between provinces world-wide.

Geology : Composite pipe models (Hawthorne 1975; modified by Mitchell 1986) and kimberlite-specific textural-genetic classifications (Clement 1982; Clement and Skinner 1985; Clement and Reid 1989; modified by Mitchell 1986, 1989) note three dominant facies : crater, diatreme and hypabyssal (Fig. 2), each with markedly different modes of emplacement. Craters have been preserved only in a few areas. They are shallow, basin-like structures less than 1500m in diameter, commonly <150m but up to 300m deep. Crater-facies rocks may comprise pyroclastic and epiclastic material. Kimberlite diatremes are vertical carrot-shaped bodies typically <1000m in diameter and <2000m deep. Diatreme-facies kimberlites comprise mainly tuffisitic kimberlite breccias which are the end products of complex fluidised intrusive systems. They are characterised by fragmental textures and incorporate juvenile lapilli-like stuctures as well as abundant country rock xenoliths. Diatremes grade with depth into complex irregular root zones. Root zones, as well as dykes and sills, consist of hypabyssal kimberlite that most commonly displays a macrocrystic texture. Bona fide kimberlite lavas or lava lakes are absent.

LAMPROITES

Lamproite was the term used early this century to describe a group of rocks with distinctive geochemistry. Since the discoveries in Western Australia, interest in these rocks has been revived and more information is now available. Lamproites include diverse rocks displaying a wide range of modal mineralogies, which is particularly noteworthy considering the small number of lamproites known.

Definition : This brief definition is modified from Mitchell (1985) and Scott Smith and Skinner (1984 a,b). "The lamproite clan are a group of ultrapotassic mafic rocks characterised by the presence of one or more of the following primary phenocrystal and/or groundmass constituents with widely varying modal abundances : titanian, alumina-poor phlogopite, Fe-rich leucite, titanian potassic richterite, forsteritic olivine, diopside, Fe-rich sanidine and titanian tetraferriphlogopite. Minor and accessory phases include priderite, apatite, wadeite, perovskite, spinel, ilmenite, shcherbakovite, armalcolite and jeppeite. Glass may be an important constituent of rapidly chilled lamproites." This definition is augmented by many other mineral and whole-rock geochemical criteria (Mitchell and Bergman 1991). Mantle-derived xenocrysts including olivine, chromite and pyrope garnet may also be present. Other phases such as analcime, barite, zeolite and carbonate are typically secondary.

Mineralogical classification : To replace archaic and confusing terminology, lamproites are classified mineralogically following the method used for kimberlites based on the modal abundances of the main constituents (Scott Smith and Skinner 1984 a,b; Mitchell and Bergman 1991). No mineral is ubiquitous in lamproites so none is excluded from the classification. This classification is best applied to magmatic rocks. A lamproite may thus be described as an "olivine phlogopite lamproite".

Geology : Lamproites comprise craters which are irregular, asymmetric, often relatively shallow (<300m; Fig. 2) and range in size up to 1500m in diameter (as shown in Fig. 4 of Scott Smith in press). Craters are infilled with volcaniclastic material, typically well bedded lapilli tuffs which are predominantly of pyroclastic origin (as illustrated for example in Fig 2.5 of Smith and Lorenz 1989). These volcaniclastic rocks are often intruded by magmatic lamproite that forms ponded lava lakes. Lamproite lavas outside craters are known but are rare. Dykes and sills also occur. In contrast to kimberlites, the textural varieties of rocks found in lamproites are similar to those of many other volcanic rocks, so existing terminology can be applied (e.g. Fisher and Schminke 1984).

DISCUSSION

Kimberlites and lamproites are similar in that they are intra-plate, mantle-derived, alkaline, small volume, volcanic rocks which can carry economic quantities of diamond as well as other mantle derived constituents. The brief review above, however, shows that these rock types are different in their petrography, mineralogy and geology. Other petrological aspects not discussed here, such as geochemistry, also separate these rock types. The differences between, and among, lamproites and kimberlites reflect different mantle sources, different petrogeneses and different near surface processes (see Mitchell 1986; Mitchell and Bergman 1991 for more detailed discussions).

Although these magmas only act as the transporting medium to the surface for the upper mantle-derived xenocrystic diamond, they must be considered separately (Scott Smith, in press). Interestingly, India has examples of an economic lamproite at Majhgawan and a province of kimberlites at Wajrakarur and Lattavaram that range from diamondiferous to barren as well as other reportedly diamond-bearing occurrences which appear not be kimberlites or lamproites (Fig. 1; Scott Smith 1989).

The differences between the "champagne glass-" versus "carrot"-shaped" of lamproite and kimberlite pipes respectively (Fig. 2) are the end result of markedly different modes of emplacement of each of the rock types. The most obvious difference between the pipe models is that kimberlites appear to form much deeper intrusions than lamproites (up to 2000m versus up to <300m) with the development of an extensive diatreme and related root zones below the crater (Fig. 2). The largest of the Wajrakarur and Lattavaram kimberlites, which is the 19.4 hectare Pipe 1 (Fig. 3), is composed of at least two rock types : mica-bearing hypabyssal kimberlite and diatreme-facies, pelletal tuffisitic kimberlite breccias (Scott Smith 1989). This strongly suggests that this body is composed of both hypabyssal and diatreme-facies kimberlite. Although further comment depends on the distribution of these two rock types within the body, the presence of both these textural types is typical of the lower parts of kimberlite diatremes as they approach the root zone. The non-circular more irregular plan view shape of the body is consistent with this suggestion (cf. Clement 1982 or Fig. 3 of Scott Smith, in press). The size of the body is perhaps somewhat larger than many root zone kimberlites. Pipes 2 to 6 in the Wajrakarur/Lattavaram province appear to be composed mainly of hypabyssal kimberlite (Scott Smith 1989). This feature together with their size (<5.5ha.) and shape (Fig. 2) suggests that they are probably root zone kimberlites. The Wajrakarur/Lattavaram kimberlites, therefore, probably represent a province of eroded diatremes. Both kimberlite and lamproite pipes have craters. There is no evidence for crater-facies material among the Wajrakarur kimberlites, again, suggesting that they are eroded kimberlite pipes. Extrusive magmatic kimberlite is not known and is notably absent from kimberlite craters. All the magmatic rocks examined from the Wajrakarur kimberlites have been classified as hypabyssal not extrusive (Scott Smith 1989).

In contrast to kimberlites, the crater forms the main part of a lamproite pipe. Majhgwan and Hinota are examples of lamproite craters which are composed predominantly of volcaniclastic rocks : glassy olivine lamproite lapilli tuffs (Scott Smith 1989). The typical infilling of kimberlite diatremes, intrusive tuffisitic kimberlite breccias, have not been observed in the Majhgwan and Hinota lamproites so there is no suggestion that the development of the equivalent of the kimberlite diatreme has occurred at these localities. Majhgawan and Hinota therefore appear to be comparable to the lamproite model (Fig. 2). The Majhgawan pipe has only been drilled to 120m so the vertical extent of the pipe is not known (Fig. 4). Hinota appears to be a shallow crater less than 80m deep (Fig. 5). If the lamproite model of relatively shallow intrusions holds for this area, it suggests that Majhgawan may have undergone limited erosion. In contrast to the lamproite model as presented in Fig. 2, it is known that Majhgawan has steep contacts of 70-75deg. (Fig. 4) which differs from the lamproite model (Fig. 1). Other examples of steep sided lamproites are known, e.g. Argyle (Jaques et al. 1986). The shapes of craters are dependent on other factors in addition to the mode of emplacement, such as the nature of the country rocks so a variety of crater shapes should be expected.

In many, but not all instances, lamproite craters are intruded by later magmatic lamproite which forms a lava lake or lava dome. The lava lakes are typically much lower in grade and uneconomic while than the volcaniclastic rocks into which they intrude have higher grades and may be economic (e.g. Jaques et al. 1986). No magmatic rocks have been described from Majhgawan (Scott Smith 1989) so this pipe appears to be an example of a lamproite where the later lava lake has not been formed. This is consistent with the fact that all of the main part of the pipe has been mined.

Not only do lamproites and kimberlites differ from each other but there are also different types within each clan of rocks. Two groups of kimberlites, the so-called Group 1 and 2 kimberlites, have been recognised (Smith 1983, Skinner 1989). Group 1 kimberlites are very similar worldwide. They can carry a full suite of mantle-derived constituents (e.g. olivine, ilmenite, garnet, chromite, clinopyroxene, orthopyroxene, zircon). The kimberlites in the vicinity of Wajrakurur in Andra Pradesh are typical examples of Group 1 kimberlites (Scott Smith 1989). Group 2 kimberlites, which are so far confined to South Africa, are typically rich in mica and do not appear to contain mantle-derived ilmenite and zircon. Virtually no information is available for the indicator minerals which occur in the Indian bodies. From the information presented above, however, it might be expected that the Wajrakarur/Lattavaram kimberlites will carry ilmenite while Majhgawan and Hinota will be devoid of ilmenite. During the limited study of the mantle-derived minerals occurring at Majhgawan by Khar'kiv et al. (1991) only one grain of ilmenite (no composition given) while common, but seemingly not abundant, pyrope garnet and chromite were recovered.

Two main groups of lamproite, leucite lamproite and olivine lamproite (sensu lato), have been recognised. Economic quantities of diamond have so far only been found in olivine lamproites. With the abundance of olivine, the olivine lamproites somewhat resemble kimberlites. This feature, as well as the presence of diamond, explains why all the occurrences now considered to be diamondiferous olivine lamproite were originally termed kimberlites including the Majhgawan and Hinota pipes. Other diamondiferous lamproites in addition to those in Western Australia and India, include Prairie Creek in Arkansas, Kapamaba in Zambia and possibly Seguela in the Ivory Coast (Scott Smith and Skinner 1984a; Scott Smith et al. 1989; Mitchell and Bergman 1991).

It is also important to be able to distinguish kimberlites and lamproites from other petrographically similar rocks, such as minettes, melilitites, alnoites and other ultramafic lamprophyres. These other rock types, so far, have not yielded significant quantities of diamond which suggests that detailed follow up work on such bodies could perhaps be avoided. However, discriminating correctly between such rocks found during prospecting, particularly when altered, is often not easy. Scott Smith (1989) reviewed the nature of all the occurrences in India which had been proposed to be kimberlites or lamproites (Fig. 1). It was shown that Majhgawan and Hinota are olivine lamproites and that the Wajrakarur/Lattavaram are the only confirmed kimberlites in India. Available data do not support the suggestions of other lamproites or kimberlites in India, except perhaps for the dykes of the Gondwana Coalfields, although a need for more detailed petrological studies is highlighted. Some of these occurrences have been reported to carry diamonds, such as Angor and Jungel (Fig. 1). Scott Smith (1989), based on petrography, suggests that Angor and Jungel are more likely to be a peridotite-pyroxenite-gabbro complex (after Mathur 1981, 1986) and meta-volcanics respectively. Another example is the Chelima suite of dykes which have been most recently suggested to be diamond-bearing lamproites but Scott Smith (1989) believes that they are more likely to be lamprophyres.

Some of the differences between kimberlites and lamproites and their significance have been discussed above. Other differences, such as the tectonic setting, are significant but have not been discussed here. It is often regarded that the tectonic setting of diamondiferous kimberlites and lamproites differs (e.g. Mitchell and Bergman 1991). Economic kimberlites have long been considered to be confined to Archaean cratons (Clifford 1966) and the Wajrakarur/Lattavaram kimberlites are a good example (Fig. 2). Diamondiferous lamproites occur both within and outside Archaean cratons (e.g. Majhgawan/Hinota and Argyle respectively; Mitchell 1991; Janse 1991). This effectively increases the potential areas for diamond exploration off the Archaean cratons to include certain Proterozoic and maybe younger terranes.

Majhgawan, Hinota and the Wajrakarur/Lattavaram kimberlites appear to be Proterozoic in age (as reviewed by Scott Smith 1989; Paul 1991). They therefore form part of a widespread occurrence of Proterozoic kimberlites and lamproites which form part of an important period of worldwide alkalic intrusive activity (Skinner et al. 1985). The occurrence of only Proterozoic diamondiferous source rocks within any craton or continent is unusual.

REFERENCES

ATKINSON, W.J., HUGHES, F.E., and SMITH, C.B., 1984. A review of the kimberlitic rocks of Western Australia. In Kimberlite. 1 : Kimberlites and related rocks. Edited by J. Kornprobst. Elsevier Press, New York, p. 195-224.

BERGMAN, S.C. 1987 Lamproites and other potassium-rich igneous rocks : a review of their occurrence, mineralogy and geochemistry. - In: Alkaline Igneous Rocks, (Eds. FITTON, J.G. anu UPTON, B.G.J.), Geol. Soc. Spec. Publ. No. 30, 103-190.

BOXER, G.L., LORENZ, V., and SMITH, C.B., 1989. The geology and volcanology of the Argyle (AK1) lamproite diatreme, Western Australia. Geological Society of Australia Special Publication 14, 1, 140-152.

BRANNER J.C. AND BRACKETT R.N. 1889 The peridotite of Pike County, Arkansas. Amer. J. Sci. 38, 50-59.

CLEMENT, C.R., 1982. A comparative geological study of some major kimberlite pipes in the northern Cape and Orange Free State. Unpublished Ph.D. thesis, University of Cape Town, South Africa.

CLEMENT, C.R., and REID, A.M., 1989. The origin of kimberlite pipes : an interpretation based on a synthesis of geological features displayed by southern African occurrences. Geological Society of Australia Special Publication 14, 1, 632-646.

CLEMENT, C.R., and SKINNER, E.M.W., 1985. A textural-genetic classification of kimberlites. Transactions of Geological Society of South Africa 88, 403-409.

CLEMENT, C.R., SKINNER, E.M.W, and SCOTT SMITH, B.H., 1984. Kimberlite redefined. Journal of Geology 32, 223-228.

CLIFFORD, T.N., 1966. Tectono-metallogenic units and metallogenic provinces of Africa. Earth and Planetary Science Letters 1, 421-434.

FISHER, R.V., and SCHMINKE, H.-U., 1984. Pyroclastic Rocks. Springer Verlag. 472pp.

GEOLOGICAL SURVEY OF CANADA Open File Report, 1989. The development of advanced technology to distinguish between diamondiferous and barren diatremes. Three parts (co-ordinated by C.F. Fipke; report preparation and interpretation by R.O. Moore and J.J. Gurney).

HALDER, D. and GHOSH, D.B., 1974. Tectonics of the kimberlites around Majhgawan, Madhya-Pradesh, India. In International Seminar on tectonics and metallogeny of Southeast Asia and Far East. Edited by M.V.N. MURTY. Geol. Surv. India, p. 47-48.

HAWTHORNE, J.B., 1975. Model of a kimberlite pipe. Physics and Chemistry of the Earth 9, 1-15.

JANSE, A.J.A, 1991a. Is Clifford's rule still valid? Affirmative examples from around the world. International Kimberlite Conference, 5, Araxa, 1991. Extended Abstracts, p. 196-198.

JAQUES, A.L., LEWIS, J.L., GREGORY, G.P., FERGUSON, J., SMITH, C.B., CHAPPELL, B.W., and McCULLOCH, M.T., 1984. The diamond-bearing ultrapotassic (lamproitic) rocks of the West Kimberley region, Western Australia. In Kimberlites I: Kimberlites and Related Rocks. Edited by J. Kornprobst. Elsevier Press, New York, p. 225-254.

JAQUES, A.L., LEWIS, J.D., and SMITH, C.B., 1986. The kimberlites and lamproites of Western Australia. Geological Survey of Western Australia Bulletin 132, 268pp.

KHAR'KIV A.D., ZHERDEV P. Yu., MAKHOTKIN I.L. and SHEREMEYEV V.F. 1991 Composition of the diamond beating rocks of the Majhgawan pipe, central India. International Geology Review 33, 269-278.

LEWIS, H.C., 1887. On diamantiferous peridotite and the genesis of diamond. Geological Magazine 4, 22-24.

LEWIS, H.C., 1888. The matrix of diamond. Geological Magazine 5, 129-131.

MADIGAN, R., 1983. Diamond exploration in Australia. Indiaqua 35, 27-38.

MATHUR, S.M. (1981): The diamond deposits of India. - Presidential Address. Proc. Indian Sci. Congress 68, (2), 1-30.

MATHUR, S.M. (1986): Panna revisited. - Indiaqua 44,(2), 23-27.

MITCHELL, R.H., 1985. A review of the mineralogy of lamproites. Transactions of the Geological Society of South Africa 88, 411-437.

MITCHELL, R.H., 1986. Kimberlites: mineralogy, geochemistry and geology. Plenum Press, New York.

MITCHELL, R.H., 1989. Aspects of the petrology of kimberlites and lamproites: some definitions and distinctions. Geological Society of Australia Special Publication 14, 1, 7-45.

MITCHELL, R.H., 1991. Kimberlites and lamproites: Primary sources of diamond. Geoscience Canada, 18, 1-16.

MITCHELL, R.H., and BERGMAN, S.C., 1991. Petrology of lamproites. Plenum Press, New York.

NAGABHUSHANAM B. and VENKATANARAYANA, B. 1985 Geology and geochemistry of kimberlites of Wajrakarur area, Anantapur district, Andhra Pradesh. - Geophysical Research Bulletin 23, (1), 43-53.

NAQVI, S.M., RAO, V.D. and NARAIN, H. 1974 The protocontinental growth of the Indian Shield and the antiquity of its rift valleys. - Precambrian Research 1, (4), 345-398.

PAUL D.K. 1991 Indian kimberlites and lamprophyres : mineralogical and chemical aspects. J. Geol. Soc. India. 37, 221-238.

REDDY, T.A.K. (1987): Kimberlite and lamproite rocks of Vajrakarur area, Andhra Pradesh. - Geol. Soc. India Journal 30, 1-12.

SCOTT SMITH, B.H., 1989. Lamproites and kimberlites in India. Neues Jahrbuch Mineral. Abh. 161, 193-225.

SCOTT SMITH B.H. In press Contrasting kimberlites and lamproites. Exploration and Mining Geology 1, No. 4.

SCOTT SMITH, B.H., and SKINNER, E.M.W., 1984a. A new look at Prairie Creek, Arkansas. In Kimberlites I: Kimberlites and related rocks. Edited by J. Kornprobst. Elsevier Press, New York, p. 255-283.

SCOTT SMITH, B.H., and SKINNER, E.M.W., 1984b. Diamondiferous lamproites. Journal of Geology 92, 433-438.

SCOTT SMITH, B.H., SKINNER, E.M.W., and LONEY, P.E., 1989. The Kapamba lamproites of the Luangwa Valley, Eastern Zambia. Geological Society of Australia Special Publication 14, 1, 189-205.

SINOR, K.P. (1930): The Diamond Mines of Panna State in Central India. The Times of India Press, Bombay. 189pp.

SKINNER, E.M.W., 1989. Contrasting Group I and Group II kimberlite petrology: towards a genetic model for kimberlites. Geological Society Australia Special Publication 14, 1, 528-544.

SKINNER, E.M.W., and CLEMENT, C.R., 1979. Mineralogical classification of southern African kimberlites. In Kimberlites, diatremes and diamonds: their geology, petrology and geochemistry. Edited by F.R. Boyd and H.O.A. Meyer.. Amer. Geophys. Union, Washington, D.C., p. 129-139.

SKINNER E.M.W., SMITH C.B., BRISTOW J.W., SCOTT SMITH, B.H. and DAWSON J.B. 1985 Proterozoic kimberlites and lamproites and a preliminary age for the Argyle lamproite pipe, Western Australia. Trans. Geol. Soc. S. Afr. 88, 335-340.

SMITH, C.B., 1983. Pb, Sr and Nd isotopic evidence for sources of African Cretaceous kimberlite. Nature, 304, 51-54.

SMITH, C.B., and LORENZ, V., 1989. Volcanology of the Ellendale lamproite pipes, Western Australia. Geological Society of Australia Special Publication 14, 1, 505-519.

Figure 1 Localities of suggested lamproites and kimberlites in India (from Scott Smith 1989)

Legend: (1) Majhgawan Mine and Hinota, (2) Angor, (3) Jungel, (4) Gondwana Coalfields, (5) Wajrakarur and Lattavaram, (6) Chelima, (7) Zangamrajupalle, (8) Maddur and (9) Warangal. Also shown are the cratons after NAQVI et al. (1974) but also see Fig. 18a of BERGMAN (1987).

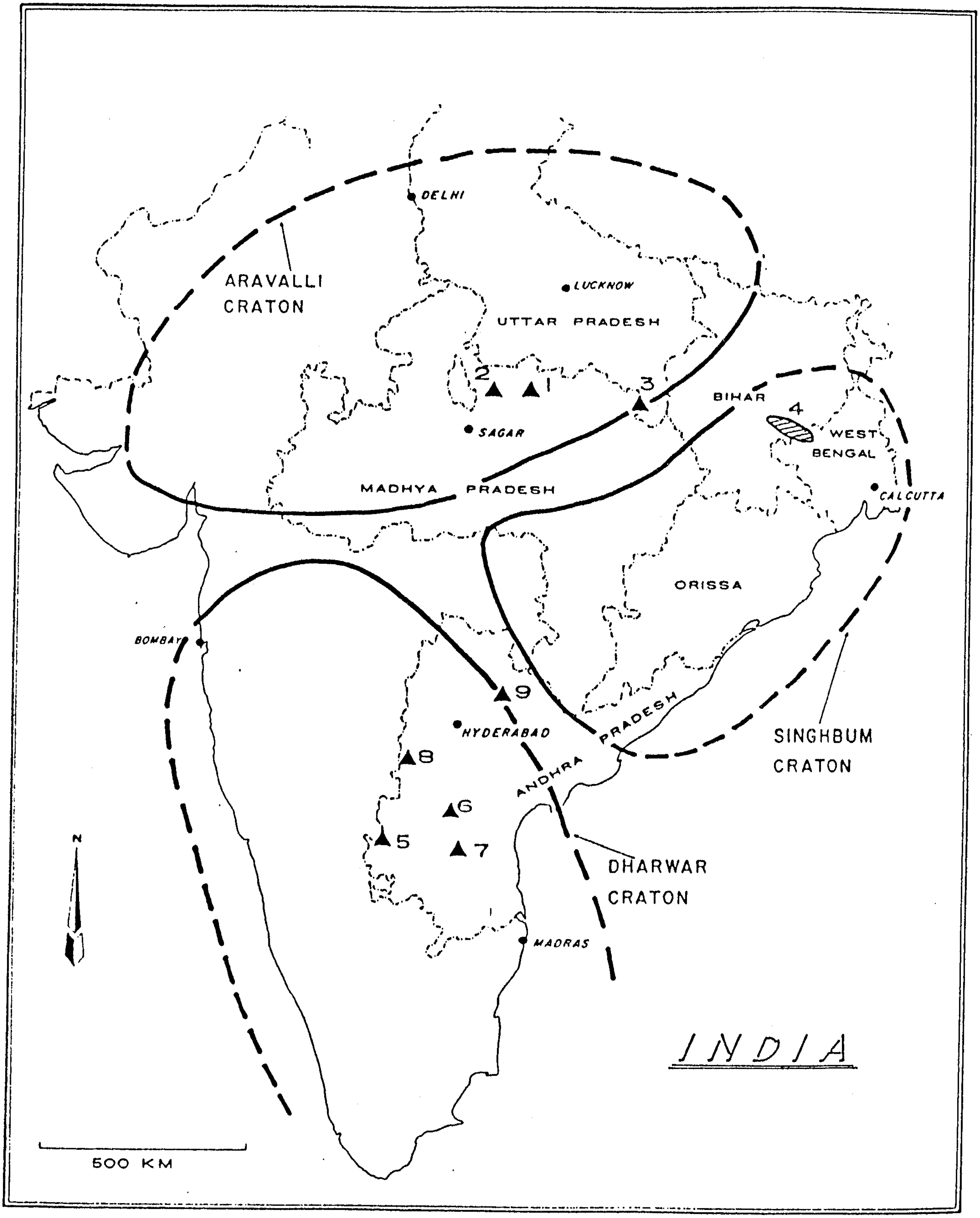
Figure 2 A comparison of schematic simplified geological models of lamproite and kimberlite pipes (from Scott Smith 1989 modified after Scott Smith and Skinner, 1984b). Not to scale.

Figure 3 Size and shape of Pipes 1 to 6 in the Wajrakarur/Lattavaram province shown in Fig. 2 (after Nagabhushanam and Venkatanarayana 1985; Reddy 1987)

Figure 4 A geological map of the Majhgawan pipe (from Halder and Ghosh 1974).

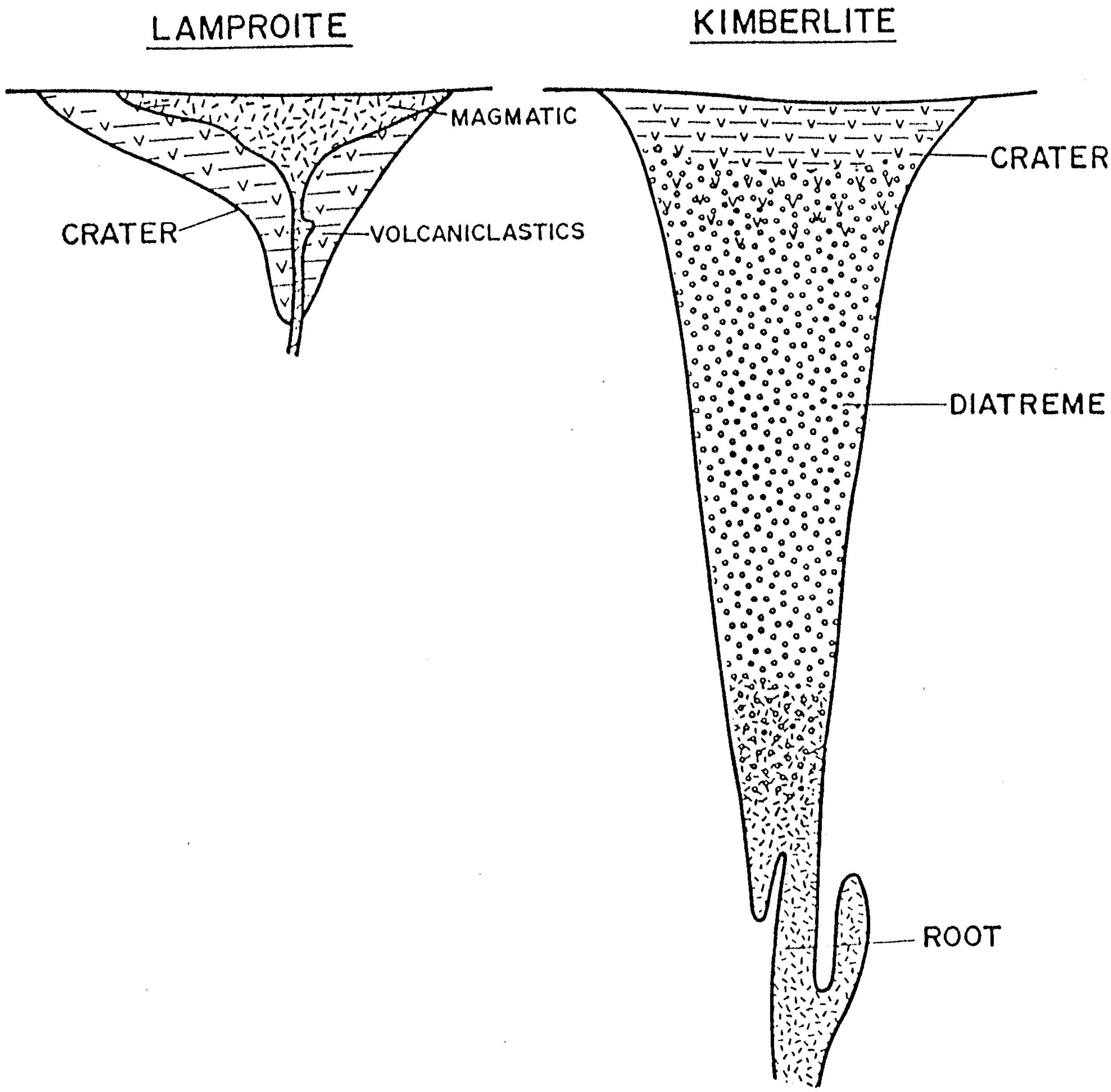
Figure 5 A geological map of the Hinota pipe (from Halder and Ghosh 1974).

Fig. 1



DELHI
ARAVALLI
CRATON
LUCKNOW
UTTAR PRADESH
2
1
3
BIHAR
4
WEST
BENGAL
SAGAR
MADHYA PRADESH
CALCUTTA
ORISSA
BOMBAY
9
HYDERABAD
ANDHRA PRADESH
SINGHBUM
CRATON
8
6
5
7
N
DHARWAR
CRATON
MADRAS
INDIA
500 KM

FIG. 2



LAMPROITE
MAGMATIC
CRATER
VOLCANICLASTICS
KIMBERLITE
CRATER
DIATREME
ROOT

Fig. 3

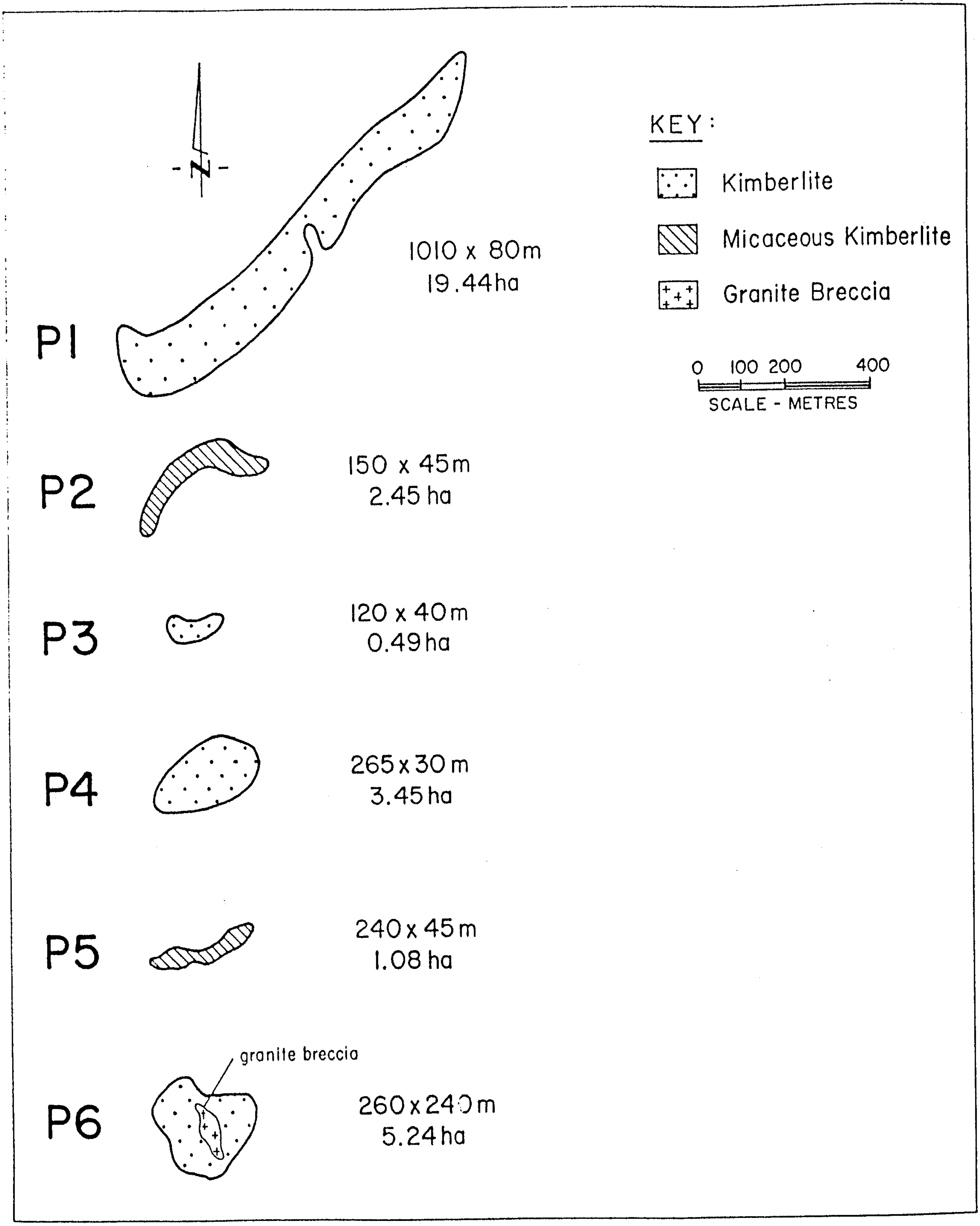
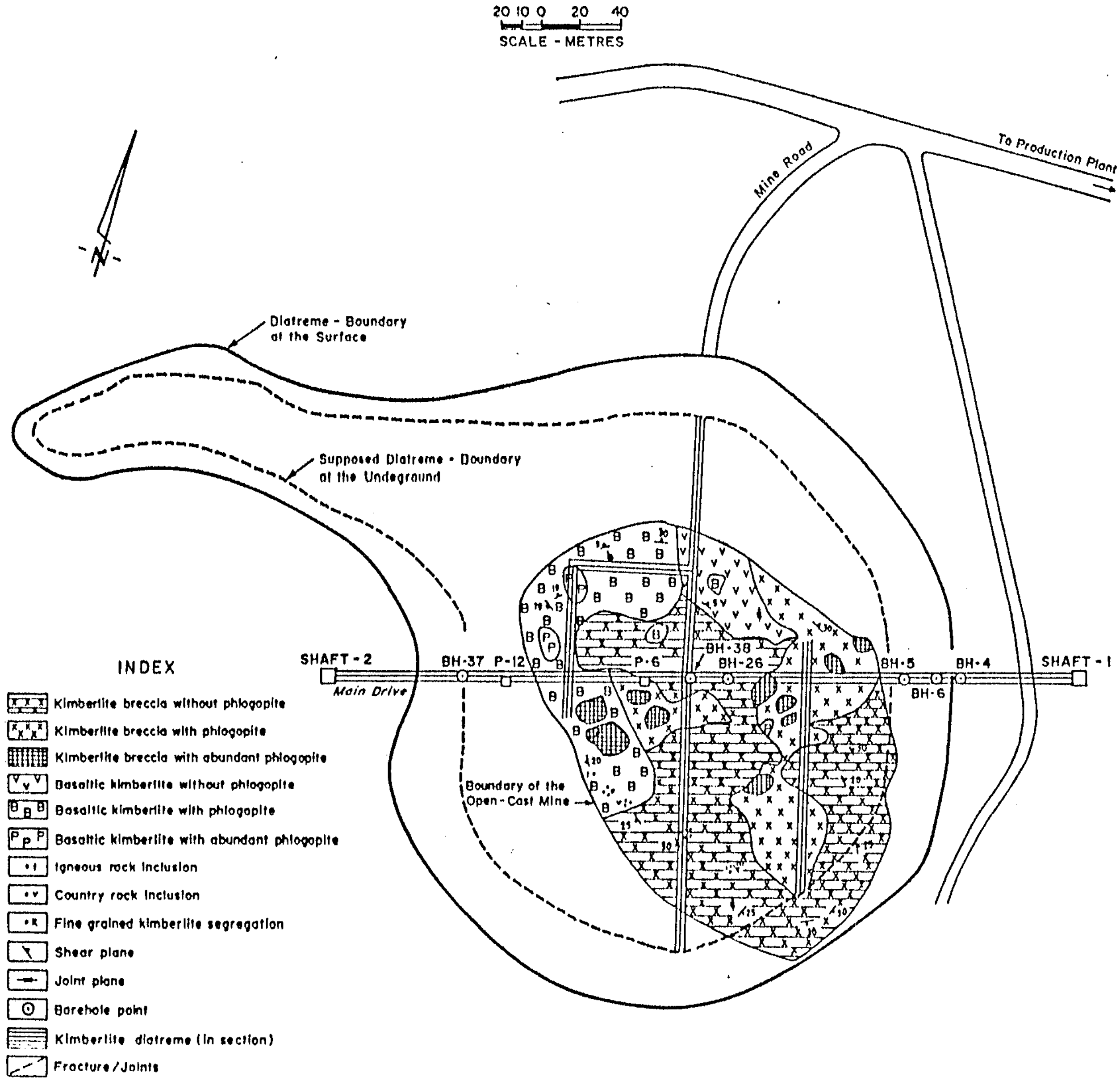
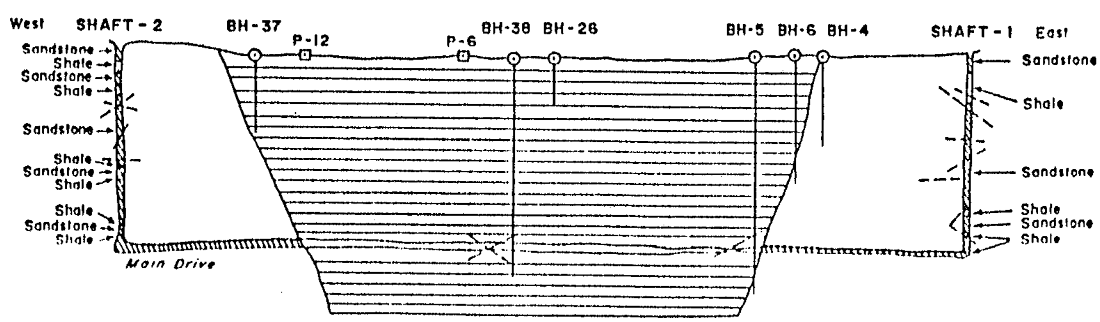

N
KEY:
Kimberlite
Micaceous Kimberlite
Granite Breccia
0 100 200 400
SCALE - METRES
P1
1010 x 80m
19.44ha
P2
150 x 45m
2.45 ha
P3
120 x 40m
0.49ha
P4
265 x 30 m
3.45 ha
P5
240 x 45 m
1.08 ha
P6
granite breccia
260 x 240 m
5.24 ha

FIG. 4

STRUCTURAL & MINERALOGICAL MAP OF THE MAJHGAWAN KIMBERLITE DIATREME

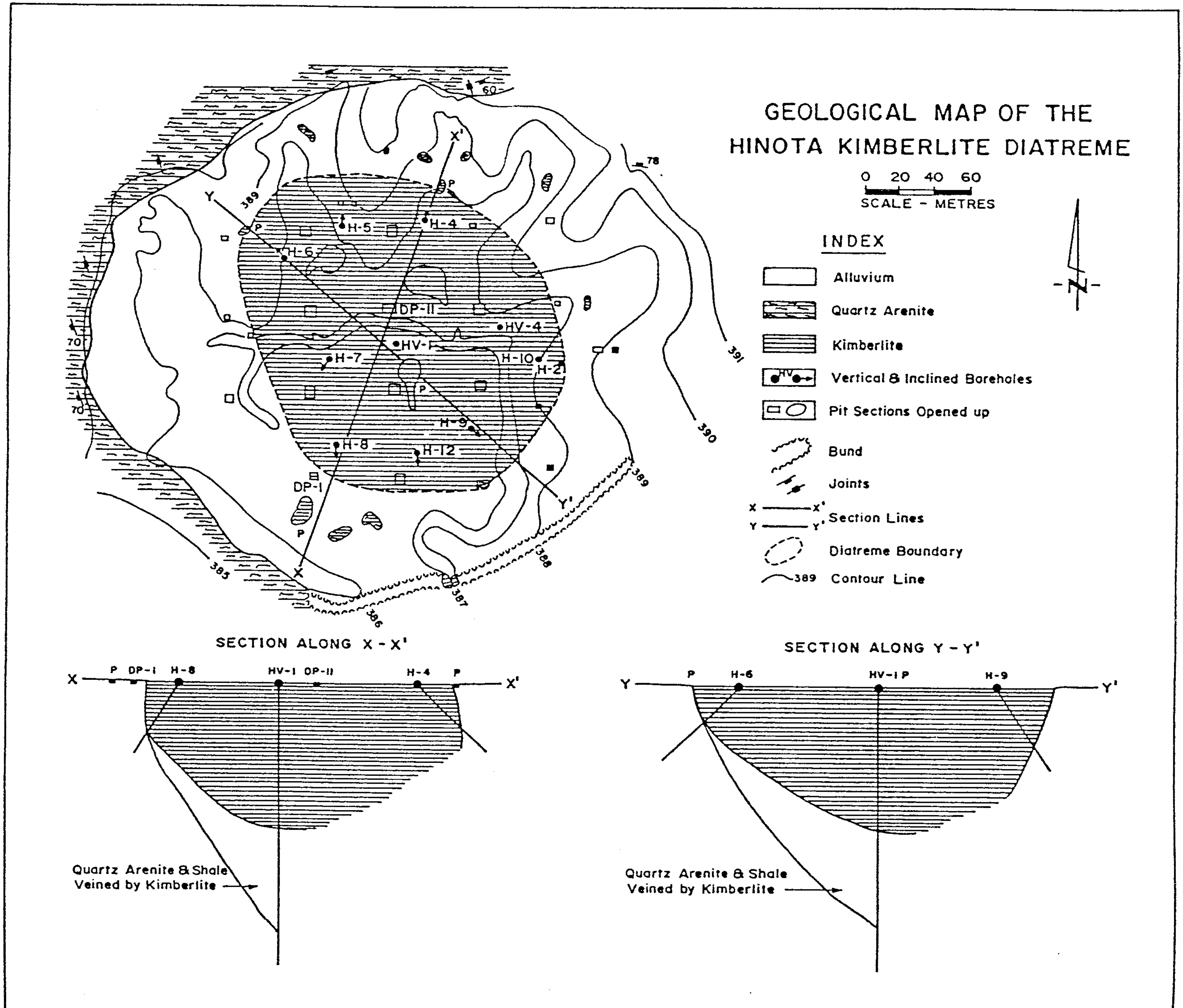


SECTION ALONG THE LINE CONNECTING THE TWO SHAFTS



(FROM HALDER & GHOSH)

Fig. 5



(FROM HALDER & GHOSH, 1974)

INTERNATIONAL ROUNDTABLE CONFERENCE
ON
DIAMOND EXPLORATION AND MINING

AT

HOTEL TAJMAHAL - 1, MANSINGH ROAD, NEW DELHI

26th & 27th November, 1992

TECHNICAL PAPERS

ORGANISED BY

National Mineral Development Corporation, India

IN COLLABORATION WITH

United Nations Department of Economic and Social Development

International Round Table Conference
On
Diamond Exploration and Mining
26th & 27th November, 1992

CONTENTS

15. P.S. Plaisted : "Diamond recovery and Processing techniques".

16. P. Henheron : "Diamond Processing".

17. L. Rombouts : "The geology of Indian diamond deposits"

18. B.C. Poddar : "Panna Diamond Belt in Central India, Geological setting and exploration strategy - A profile".

19. A.K.Chatterjee and K.S.Rao : "Majhgawan Diamondiferous pipe (Madhya Pradesh, India)- A Geological Appraisal.

20. T.V.Viswanathan: S.V.Satyanarayana "Geological Setting of diamondiferous primary and secondary rocks in Andhra Pradesh".