SHORT COMMUNICATION

LAMPROPHYRE DYKES IN CHOTANAGPUR GNEISSIC COMPLEX, NEAR SIMDEGA, GUMLA DISTRICT, JHARKHAND

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Lamprophyre dykes are reported from the Precambrian metamorphites of the Chotanagpur Gneissic Complex near Simdega, Gumla district, Jharkhand. Petrological and petrochemical studies indicate that they are calc-alkaline lamprophyres. The economic significance of these lamprophyres is discussed in light of their proximity to (i) the gold prospects in its strike continuity and (ii) reported occurrences of diamonds in the major drainage basins of the region.

Introduction

The Chotanagpur Gneissic Complex (CGC, inset map in Fig.1) that occurs to the north of the Singhbhum orogenic belt (SG, inset map in Fig. 1) comprises granites, gneisses, supracrustal enclaves with anorthosites and ultramafic intrusives (Sarkar, 2000). The contact between CGC and SG, in this region, is marked by a major tectonic zone referred to as South Purulia shear zone (Basu, 1994). The region to the south of South Purulia shear zone, that exposes Singhbum Group of rocks are known to contain alkali magmatic rocks (for details *see* Basu *ibid*). Recently, Swain et al. (1997) have reported an ultrapotassic dyke swarm presumably of minette/lamproite affinity near Kansabal in Raigarh district of Chattisgarh in the CGC. During a regional geological reconnoitory survey aided by the high altitude aeromagnetic maps (NPAS) dykes of lamprophyric composition have been recorded for the first time in CGC near Kurdeg-Simdega area of Gumla district in Jharkhand. Simdega is situated at about 200 kms SSE of minette-lamproite bearing Gondwana coalfields. In a dominantly undulating terrain, N-S trending Ib and Sankh rivers constitute the main drainage of the region. This paper presents field, petrographic and geochemical aspects of these dykes and discusses their economic significance.

Geological Setting

Two litho-units dominate the Chotanagpur Gneissic Complex in the study area, (Fig.1) namely: (i) grey, banded, well foliated granite-gneiss and (ii) an elliptical outcrop of composite-gneiss. The granite-gneiss contains enclaves of older supracrustals of varying dimensions oriented along the ENE-WSW regional trend. These supracrustals comprise metabasics, metapelites, and metapsammites. The contact region of granite-gneiss and metapelites is the zone of extensive pneumatolytic activity as indicated by the ubiquitous development of tourmaline in the form of quartz-tourmaline and tourmaline-biotite rocks. Few bands of banded ferruginous quartzite occur towards northeastern parts. The granite-gneiss is traversed by several mafic/ ultramafic dykes and quartz/pegmatite veins. The aeromagnetic features of the study area are also shown in the Fig.1. The salient points of interest are: (i) the central part is characterised by a zone of circular/elliptical magnetic highs (ii) the contact zone of metapelites and granite-gneiss is characterised by high magnetic axis. The area has undergone polyphase deformation but present disposition of the outcrops is engineered by a second generation folding that has resulted in ENE closing synformal structure whose axial trace coincide with the high aeromagnetic anomaly. At few places, mainly near contact zones of granite and metapelites, gold prospects are located which are currently being explored. In the central parts, nearer to the elliptical magnetic high, dykes of lamprophyric composition are recorded.

LAMPROPHYRES

About 15 km west of Simdega, three north-south trending dykes of lamprophyric composition are located. Two of these occur in granite-gneiss and one close to the granite-gneiss contact with the metapelites. Though the granite-gneiss and metapelite contact trend ENE-WSW to E-W, the dyke along the contact region maintain N-S trend. The individual dykes vary in width from 4-6 m and in length from 200 to 500 m. These are medium grained, melanocratic, and micaceous linear bodies with yellowish brown to reddish

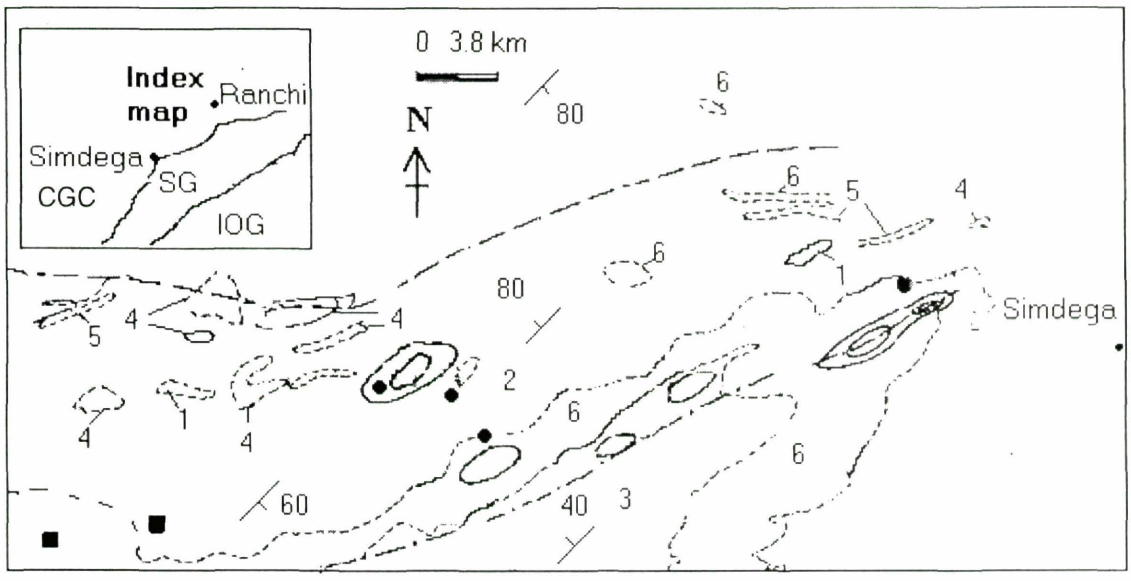

Fig.1. Generalized geological map of the area around Simdega, Gumla district, Jharkhand, showing aeromagnetic features and lamprophyre locations. Explanation of numbers are: **1.** Quartz veins, **2.** granite-gneiss, **3.** migmatitic gneiss, **4.** metabasics, **5.** quartzite, **6.** mica schist. Filled square = Gold occurrences, filled circle = lamprophyre occurrences. Bold lines with dot represents magnetic axis (high), bold closed contours represents high magnetic anomalies and bold line without dot represent magnetic axis (low). Explanation of the index map: CGC – Chotanagpur Gneissic complex, SG – Singhbum Group of rocks, IOG – Iron Ore Group of rocks. The Scale of the index map is about 70 km to a centimetre.

brown weathered surface. The rock is holocrystalline, exhibits porphyritic texture with euhedral crystals of green amphiboles and greenish-brown biotite embedded in a fine-grained feldspathic and ferromagnesian matrix. The rock also contains rare xenocrysts of pale to deep green, 1 to 4 cm size amphibole and leucocratic (grey to pinkish grey, coarse grained) fragments (Fig. 2).

Fig.2. Field photograph of the lamprophyre body. Note leucocratic patches representing felsic differentiates in the lamporphyre. The length of the scale is about 12 cm.

Under the microscope, these lamprophyres exhibit porphyritic, glomeroporphyritic, panidiomorphic, sub-ophitic and decussate textures. Hornblende (bluish green-green-yellowish green pleochroism) occurs both as large euhedral grains and smaller microlites in the matrix. Pseudohexagonal (Fig. 3) and battlemented (Fig. 3 and 4) biotite (pale green to dark green dichroism) occurs in glomeroporphyritic clusters. They have pleochroic halos and exsolved stringers of sulphides and ilmeno-magnetite along the cleavage traces. The matrix mainly consists of sub-hedral feldspar, randomly oriented, fine-grained biotite and amphiboles. The feldspars are mainly potash feldspar (microcline, orthoclase) and sub-ordinate calcic plagioclase. The plagioclase is clouded and shows alteration. The accessory minerals include euhedral grains of sphene, epidote, apatite and opaque minerals. Ore-minerographic studies indicate minor disseminations of chalcopyrite stringers along cleavage traces of host minerals (biotite). Distinctly pleochroic and anisotropic (anisotropy caused by intense internal reflections) rhombohedral clusters of sphene are noted predominantly within amphiboles and to a lesser extent along the grain margins of the castled biotite.

Chemical analyses of five lamprophyres and one leucocratic fragment carried out by XRF method are

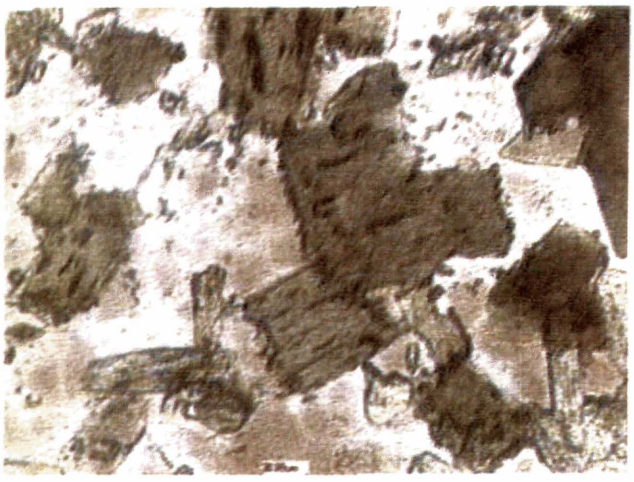

Fig.3. Photomicrograph showing glomeroporphyritic clusters of biotite in a matrix dominantly composed of clouded potash feldspar. Note pseudohexagonal nature of the few biotites (extreme right).

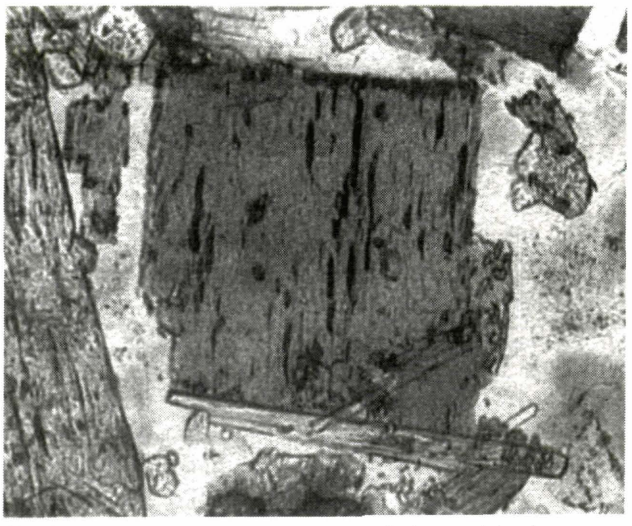

Fig. 4. Photomicrograph of a large euhedral, squarish, phenocryst of biotite in Simdega lamprophyre. Note battlemented margin of the biotite. The stringers along the cleavage traces may be the exsolved titanium bearing (ilmenite) and/ or sulphide bearing (chalcopyrite) phase(s).

provided in the Table 1. The lamprophyres are characterised by low to moderate silica (50%-57%), low alumina (9.6% to 12%) and very low soda (maximum = 0.28%). These are distinctly high calcic (5.22 % to 8.44%), high magnesia (6.59% to 9.32%) and high potassic rocks (6.65 to 7.96 %). In SiO_2 vs Alk diagram (Fig.5) these rocks plot in the field of alkaline rocks. In those discriminant diagrams that classify the lamprophyre fields (Figs. 6 and 7), the samples plot in calc-alkaline lamprophyre field. Although these are

Table 1. Major element chemistry of Simdega lamprophyre and its xenolithic fragments

Sl.No.	1	2	3	4	5	6
SiO_2	52.42	53.57	50.04	50.42	57.08	60.96
TiO_2	1.23	1.22	1.25	1.25	0.75	0.63
Al_2O_3	11.34	12.00	9.85	9.68	11.43	14.75
Fe_2O_3*	7.77	7.80	9.50	9.39	7.07	3.63
MnO	0.17	0.19	0.17	0.15	0.11	0.09
MgO	7.65	7.13	9.32	8.81	6.59	2.12
CaO	7.45	6.01	8.44	8.38	5.22	3.44
Na_2O	0.03	0.28	bld	bld	0.17	0.23
K_2O	7.51	7.96	6.65	7.22	7.83	9.54
P_2O_5	1.58	1.21	1.65	1.43	0.94	0.23
Cr_2O_3	0.04	0.05	0.06	0.06	0.05	bld
NiO	0.03	0.03	0.04	0.04	0.02	bld
BaO	1.05	0.81	0.87	0.79	0.92	2.16
LOI	0.41	0.70	0.84	0.97	1.12	0.63
Total	**98.68**	**98.96**	**98.68**	**98.59**	**99.30**	**98.41**

*Total Fe as Fe_2O_3, bld = below level of detection

1-5 are the analyses of lamprophyre, and 6 is the analysis of leucocratic fragment.

moderately rich in Cr and Ni, the most distinctive feature of these bodies is the very high content of barium (BaO ranges between 0.79% and 1.07%). In terms of their K_2O content, the Simdega lamprophyres are potassic to ultrapotassic (6.65 to 7.96%). Their K_2O/Na_2O ratio is very high, a feature characteristic of lamprophyre. The petrographic and petrochemical studies indicate that these dykes can be classified as minette-vogesite variety of calc-alkaline lamprophyres. Very high potash and barium suggest that these lamprophyres have a lamproitic affinity. One single analysis of the feldspathic segregates suggests that it is

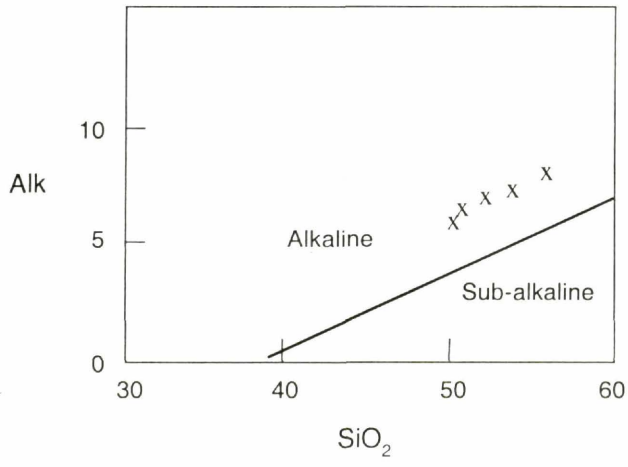

Fig.5. SiO_2 *vs.* Alk diagram for the Simdega lamprophyres.

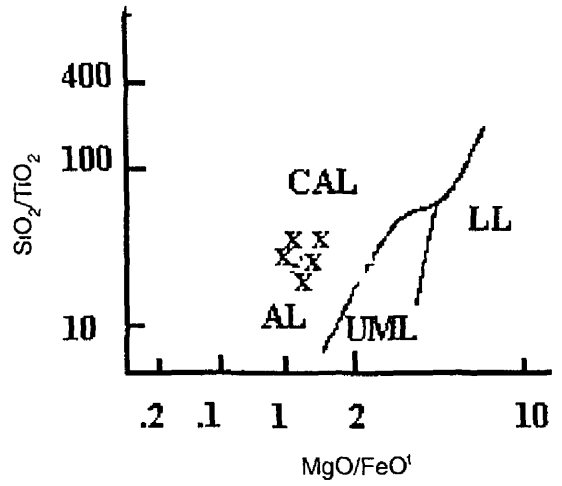

Fig.6. MgO/FeO' *vs* SiO_2/TiO_2 diagram for the Simdega lamprophyres Explanation of symbols, CAL – calc alkaline lamprophyres, UML – ultramafic lamprophyres, AL – alkaline lamprophyres and LL – lamproites

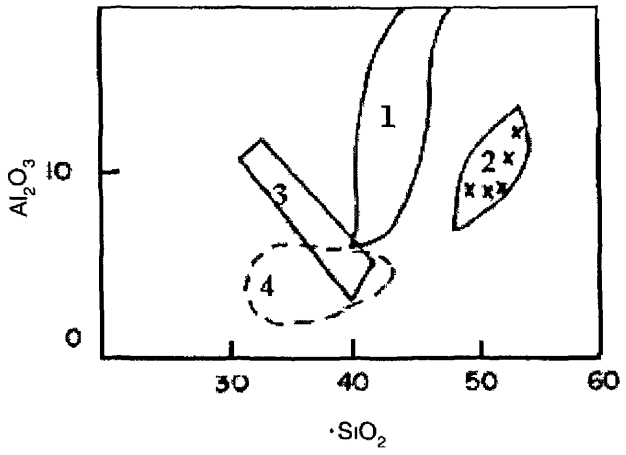

Fig.7. SiO_2 -Al_2O_3 bivariate plots (*after* Rock and Paul, 1989) showing discriminant fields of different varieties of lamprophyres Explanation to the numbers in the figure are **1.** field of alkaline lamprophyres, **2.** field of calc-alkaline lamprophyres, **3.** lamproites and **4.** kimberlites

moderately rich in silica and alumina, low in iron and magnesia but extensively rich in potash (ultrapotassic rock ?) Significantly its BaO content is abnormally high (i e 2 16%) Since these fragments also have similar chemistry (high K_2O and BaO) it suggests that these fragments may be genetically related to the lamprophyric bodies (like early differentiated segregates)

DISCUSSION

Basu (1994) has reported alkali magmatism close to South Purulia shear zone within the Singhbhum Group of rocks The present report on the other hand records alkali magmatism in the form of lamprophyre dykes to the north of the shear zone but within Chotanagpur Gneissic Complex The lamprophyres that occur closest to the Simdega ones are the lamprophyres of Gondwana basin in the Damodar Valley (Basu et al 1997)

Recent publications on lamprophyres have drawn attention towards importance of recognition of this diverse group of rocks because of their importance in diamond and gold exploration The Simdega lamprophyres occur in close proximity and in strike continuation of the known gold occurrences, which are being currently in focus for their economic viability Besides this, the major drainage basins of the region namely Ib, Maini, Mind and Sankh rivers at the tri-junction of Jharkhand - Chattisgarh - Orissa are known to contain diamonds since historical times Therefore concerted efforts are needed for an intense search of related rocks like lamproites and kimberlites in the area

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References

Basu, A , Bhattacharya, A L and Paul , D K (1997) Petiology and geochemistry of the lamprophyric rocks from the Bokaro coal field, Jharkhand and their economic potential Jour Geol Soc India v 50, pp 255-256

Basu, S K (1994) Alkaline-carbonatite complex in Precambrian of South Purulia shear zone, Eastern India, Its characteristics and mineral potentialities Indian Minerals v 47, No 3, pp 179-194

Rock, N M S and Paul, D K (1989) Lamprophyres, lamproites and Kimberlites in India A bibliography and preliminary appraisal Mem Geol Soc India, no 15, pp 291-311

Sarkar, S C (2000) Crustal evolution and metallogeny in the Eastern Indian Craton Geol Surv India Spec Publ No 55, pp 169-194

Swain, P K , Sinha, P K and Chatterjee, D P (1997) Regional search for kimberlitic diatereme and dykes in Raigarh district Madhya Pradesh Rec Geol Surv India, v 130, pt 6, pp 139-141

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