



PETROLOGY OF P-5 AND P-13 KIMBERLITE FROM LATTAVARAM KIMBERLITE CLUSTER, WAJRAKARUR KIMBERLITE FIELD, ANDHRA PRADESH, INDIA

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INTRODUCTION

The Dharwar craton of India (Fig. 1) is divided into Eastern Dharwar Craton (EDC) and Western Dharwar Craton (WDC) along crustal scale shear zone located along the eastern margin of the Chitradurga schist belt (Swami Nath et al., 1976; Drury et al., 1984; Chadwick et al., 2000). All the kimberlites and lamproites so far discovered in south India form part of EDC. The kimberlites occur in clusters in four identified fields, namely, 1. Wajrakarur Kimberlite Field (WKF), 2. Narayanpet Kimberlite Field (NKF), 3. Raichur Kimberlite Field (RKF), and 4. Tungabhadra Kimberlite Field (TKF). Most of the WKF pipes are diamondiferous. Besides the four kimberlite fields there are two lamproite fields, namely, 1. Krishna Lamproite Field (KLF) and 2. Nallamalai Lamproite Field (NLF) which also form part of EDC (Fig. 1; cf. Ravi et al., 2009).

WAJRAKARUR KIMBERLITE FIELD

The Wajrakarur Kimberlite field (120 km X 60 km) lies in Anantpur district, Andhra Pradesh and host 30 kimberlite pipes distributed in five clusters, namely, Wajrakarur cluster (7 pipes), Lattavaram cluster (7 pipes), Chigicherla cluster (4 pipes), Kalyandurga cluster (6 pipes) and Timmasamudram cluster (6 pipes) (Reddy, 1987; Nayak and Kudari, 1999; Sravan Kumar, 2004; Mukherjee et al., 2007; Srinivas Choudary et al., 2007). The kimberlites of WKF are hosted by the

granites and gneisses of the Eastern Dharwar Craton (Figs. 1, 2). The detailed account on the mode of occurrence and characteristics of the individual pipes of WKF are given by Neelkantam (2001). The kimberlite exposures are capped by 0.5 to 1.5 m thick calcrete. Kimberlites of WKF are of middle to late Proterozoic age ranging from 840 to 1153 Ma (Paul et al., 1975; Anil Kumar et al., 1993, 2007; Chalapathi Rao et al., 1996). Traditionally, all the potassic-ultramafic intrusions of this region were classified as kimberlites. Recent reclassification of a kimberlite Pipe-2 as lamproite (Mitchell, 2010) from the Wajrakarur Kimberlite Field necessitated re-look of the other kimberlite bodies in the region with a view to classify them as per mineralogic-genetic classification scheme (Mitchell, 1986). Thus two pipes P-5 and P-13 of Lattavaram cluster, in Wajrakarur Kimberlite Field were chosen for detailed mineralogical studies and the results are presented in this paper.

GEOLOGY OF PIPE-5 AND PIPE-13:

The pipe P-5 is situated at about 1km east of village Muligiripalli (Fig. 2). Outcrops of medium to fine grained kimberlite with autoliths and crustal xenoliths occur under a less than a meter calcrete cover. This as an elongated body. The main crustal fragment is of pink granite that surrounds the pipe rock. The kimberlite outcrops are intricately associated with boulders of pink granite. The rock is melanocratic to hypermelanic, hard and compact (Fareeduddin, 2008).

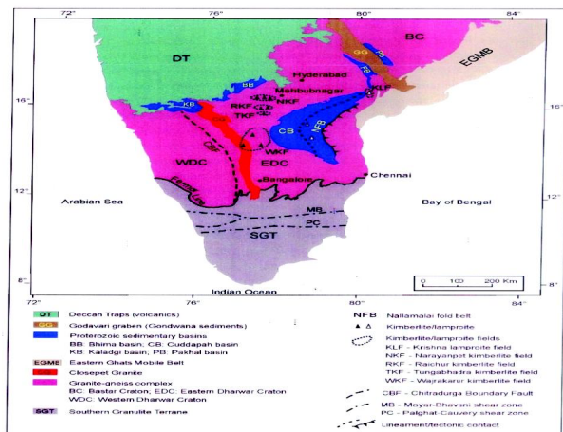


Figure 1. Generalised geological map of southern India showing kimberlite and lamproite fields in the Dharwar Craton (cf. Ravi et al., 2009).

Pipe P-13 referred to as Thummatapalle kimberlite occurs at about 1.4 km NE of Thummatapalle village (Fig. 2). It is situated very close, 2.5 km SW of the Mulgirapalle pipe P-5. The oval shaped body is emplaced into the younger granitoids. A few melanocratic fresh outcrops of hardebank variety represent kimberlite body whereas the rest of the body is highly weathered and carbonated. In hand specimens olivine macrocrysts and megacrysts upto 5 cm size can be found. The phlogopite content is highest among all kimberlite samples of WKF (Fareeduddin, 2008).

PETROLOGY OF PIPE-5 AND PIPE-13:

The pipe P-5 and P-13 rock shows inequigranular texture with macrocrysts and microphenocrysts in a fine grained segregated groundmass. Xenoliths and xenocrysts are observed at places in both the pipes.

Both the kimberlites have olivines (fresh and serpentinised) as the characteristic major mineral. The prominent groundmass minerals in both constitute monticellite-kirschsteinite, spinel, perovskite, phlogopite, apatite, magnesian ilmenite, pyroxene along with serpentine, chlorite and carbonate.

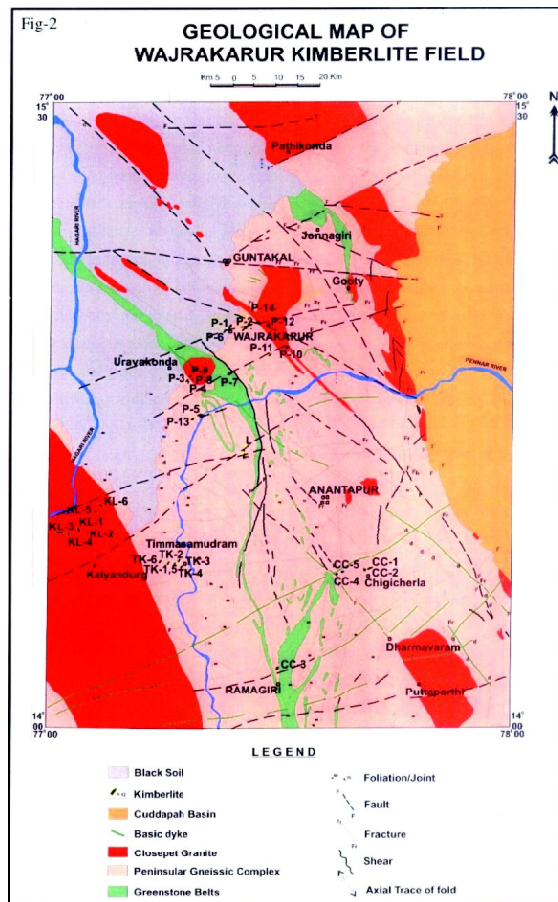


Figure 2. Geological map of Wajrakarur kimberlite field, Anantapur district, Andhra Pradesh (cf. Ravi et al., 2009).

The pipe P-5 and P-13 kimberlites exhibit macrocrystal textures and have two generations of olivine with variable contents of macrocrystic (upto 6mm) and micro-phenocrystic olivine. At places polycrystalline olivine grains are observed. The macrocrystic olivine is fresh compared to the groundmass and microphenocrystic olivines that are largely altered to serpentine.

The phlogopites from P-5 are low in alumina ($Al_2O_3 < 8\%$) also reported by Scott Smith, 1989, compared to those from P-13 ($Al_2O_3 < 12\%$). Micas from both the pipes are barium poor ($BaO < 2\%$). The titanium content is higher for P-13 phlogopites (up to 5 wt % TiO_2) compared to P-5. At places poikilitic laths of phlogopite contain inclusions of perovskite and spinel.



The P-5 has diopside laths occurring as clusters whereas the P-13 has minor amount of pyroxene and is almost devoid of these pyroxene clusters.

Both the pipes are characterized by the presence of macrocrystal (0.1-0.5mm) and groundmass (0.001-0.1mm) spinels. Both the pipes have atoll and necklace textured spinels. The atoll spinel in Fig. 3 has Ti-poor and chromium enriched core and Ti-rich and chromium poor rim (Table 1). Four varieties of spinels i.e. ulvospinel, magnesium ulvospinel, magnesium chrome spinel and magnetites are recorded in both the pipes. The ulvospinels, most dominant among spinels, from both the pipes are low in alumina (< 3 wt %), high in titanium (10-20 wt %) and iron (>60 wt%). The spinels exhibit compositional trends identical to those found in kimberlite magmatic trend T2. Intergrowth of spinel and perovskite is observed at number of places.

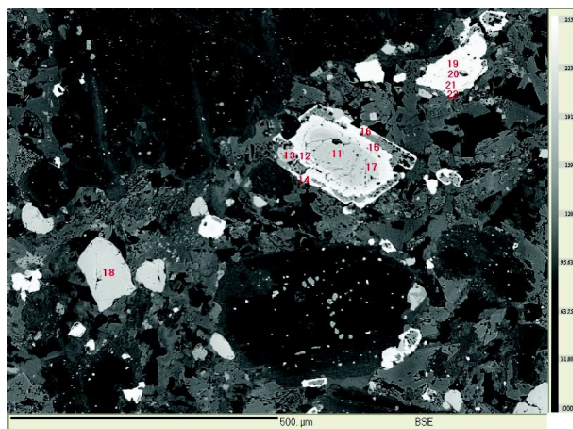


Figure 3. Atoll spinel in P-5. The composition at the points marked in the figure are given in Table 1.

Table 1. Atoll spinel compositions at the points marked in the above figure.

wt%	11	12	13	14	15	16	17
MgO	13.92	0.55	0.09	0.31	2.03	0.22	12.88
CaO	0	0.17	38.98	0.48	2.15	0.3	0.03
MnO	0.24	2.01	0.03	1.29	2.17	1.4	0.24
FeO	14.07	72.26	1.5	75.04	63.87	76.57	15.89
Al ₂ O ₃	18.44	1.35	0.14	0.37	1.93	0.65	17.85
Cr ₂ O ₃	50.85	4.75	0.03	0.27	5.17	0.39	51.55
SiO ₂	0.09	0.19	0.06	0.83	3.53	0.19	0.13
TiO ₂	0.1	12.62	56.13	12.03	14.56	12.99	0.15
Total	97.79	93.97	97.03	90.72	95.51	92.78	98.79

Euhedral to subhedral grains of perovskites with bimodal size distribution occur as discrete grains throughout the rock. Perovskites also occur in association with spinels. They often form necklace around altered olivine grains. They have in general low LREE contents (< 3 wt %), but in a few grain the LREE content goes upto 16 wt % (Ce₂O₃-5-11 wt %; La₂O₃-2-6 wt %). P-5 perovskites have marginally higher content of LREE's compared to P-13 perovskites.

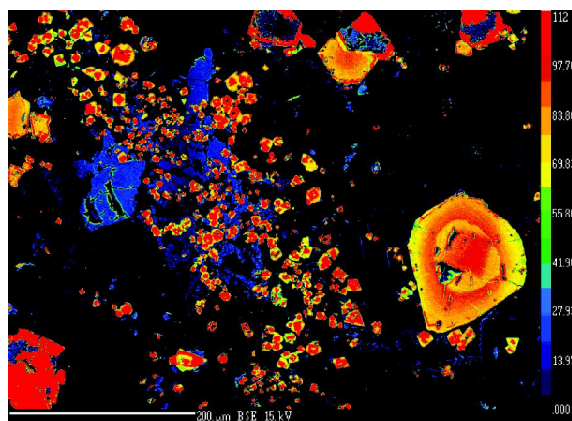


Figure 4. Bimodal size distribution of perovskites in pipe P-5. The very small grains are enriched in LREE's compared to the grain lying in the lower right corner.

Pipe P-13 has angular magnesian ilmenite grains varying in size from 0.2mm to 1.5mm often bordered by numerous small euhedral to subhedral grains of perovskite and ulvospinel. The Mg-ilmenite grains show fine exsolution lamellae of chrome ulvospinel and ilmenite (Figs. 5 and 6, table 2). The composition of ilmenites is in the ilmenite-geikielite range. 4,6- host Mg-ilmenite

Table 2. Compositions of Mg-ilmenite and chrome-ulvospinel and ilmenite-ilmenite intergrowths in pipe P-13

wt%	3	4	5	6	15	19	20	21	22	31
TiO ₂	23.09	57.65	18.2	55.75	52.43	56.12	52.24	56.24	51.51	56.49
Al ₂ O ₃	1.45	0.01	0.42	0.02	0.14	0	0.27	0.05	0.1	0
MgO	10.8	14.15	1.59	13.62	12.44	14.24	13.75	14.21	12.45	13.85
MnO	0.8	0.77	2.45	0.71	0.49	0.58	0.57	0.53	0.54	0.57
FeO	36.58	25.27	60.04	27.81	29.58	26.23	27.25	26.45	29.7	26.78
Cr ₂ O ₃	26.64	1.15	11.87	0.61	4.01	1.26	4.64	1.65	3.52	0.92
Total	99.36	99	94.57	98.52	99.09	98.43	98.72	99.13	97.82	98.61

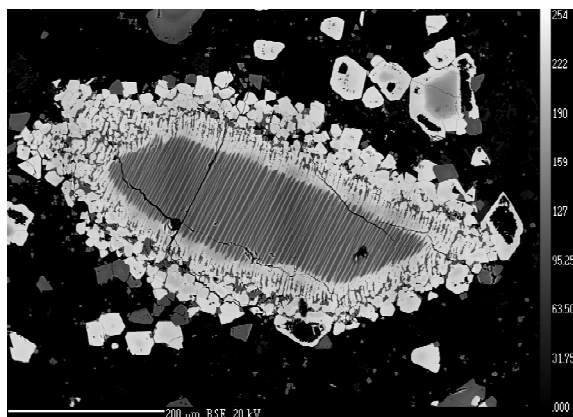


Figure 5. Mg-ilmenite megacryst with exsolved chromeulvospinel in P-13. The grain boundaries of the Mg-ilmenite decorated by ulvospinel and perovskite.

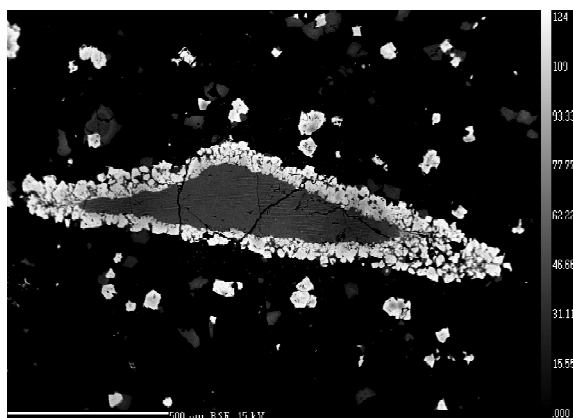


Figure 6. Megacryst of ilmenite with exsolved ilmenite rods in pipe P-13. The megacryst margin is decorated with ulvospinel and perovskite.

and 3,5-exsolved chrome ulvospinel; 15,20,22-host ilmenite and 19,21,31 exsolved ilmenite.

CONCLUSIONS

1. The mineralogical data suggests that both the kimberlites can be named as hypabyssal facies phlogopite kimberlites.
2. P-13 has more volume percent of macrocrysts, mg-ilmenite, phlogopite, spinels and perovskite compared to P-5.
3. The two pipes represent polyphase intrusions in close proximity within Lattavaram region

where P-5 type bodies represent more evolved magmas compared to P-13 type kimberlitic intrusions.

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