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Geochemical Characterization and Provenance Study of Ilmenites from Fluvial Sediments of River Cauvery in Parts of Tamil Nadu, Southern India

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Abstract: The Cauvery river is the third longest flowing river in South India. This river flows through three southern Indian states (Karnataka, Tamil-Nadu and Puducherry). The river Cauvery takes its birth at a place called Talacauvery in the state of Karnataka, and after a long journey of 800 km from the Western-Ghats finally forms a delta and joins the Bay of Bengal in the east. This river traverses high grade metamorphic rocks. Ilmenites are good indicators of provenance and several researchers throughout the globe have contributed on this aspect. Present study is focused on chemical characterization of the detrital ilmenite from the fluvial sediments of downstream of the river Cauvery. The TiO_2 content of ilmenites varies from 46.42 to 51.28 wt%, whereas iron oxide values range between 46.35-50.68 wt. %. The detrital ilmenite grains are primary in nature and have not subjected to any alteration. By chemistry we can conclude that basic suites are source for the ilmenites in fluvial sediments of river Cauvery.

Keywords: Ilmenite, Cauvery, provenance, Precambrian rocks, southern granulite terrain, fluvial sediment.

Introduction

Heavy minerals are path finders for provenance. Various heavy minerals such as garnet, zircon, and amphibole are found along the upper reaches of the river Cauvery and its tributary river Kabini (Prakashnarasimha et al., 2018). Ilmenite generally occurs in a wide variety of igneous rocks, both intrusive and extrusive, as well as pegmatite and other vein rocks and even some metamorphic rocks, especially gneiss (Ramdohr, 1980). Previous studies of detrital ilmenite also suggest that the variation in its element content is sufficient to provide an unmistakable signature to determine sediment source (Darby et al., 1985). Detrital ilmenite is commonly present as a large part of sand particles (Pettijohn et al., 1987). Several researchers worked on the ilmenites across the global level to understand the source from the geochemistry of ilmenites (Hegde et al., 2006; Sukumaran et.al., 1994; Grigsby., 1992). Present study is aimed at chemical characterization and provenance of the detrital ilmenite from the fluvial sediments from downstream of the river Cauvery.

Cauvery river is an easterly flowing river of the Peninsular India that runs across three of the southern Indian states (Karnataka, Tamil-Nadu, Puducherry). The third largest river of southern region, begins its 800 km long journey from the western Ghats, traverses through Mysore plateau and finally forms a delta on the eastern coastline of the subcontinent (Poompuhar) before falling into the Bay of Bengal. The Cauvery river basin lies between latitude 10°09'N to 13°30'N and longitude 75°27'E and 79°54'E. The lithological units along the course of river Cauvery constitute Precambrian rocks, principally the gneiss, granulite, laterite, and tertiary sediments (Pichamuthu., 1978). In the upper and middle parts, the river drains through granitoids-gneisses, granulite, and ancient supra-crustal belts composed of meta-igneous, meta-sedimentary rocks, and carbonate rocks (Ramakrishna and Swaminath., 1981; Prakash Narasimha et.al., 2009, Pichamuthu., 1976). Lower part of the river basin is underlined by Cretaceous sediments (Sundaram and Rao, 1981; Subramanian and Selvan, 2001).

Materials and Methods

Sediment samples were collected from the river at eight locations with an interval of 60 km along the course of Tamil-Nadu part of river Cauvery (Fig. 1). Collected samples were dried and then subjected to the sieving in the sizes of 60, 120, and 180-micron mesh.

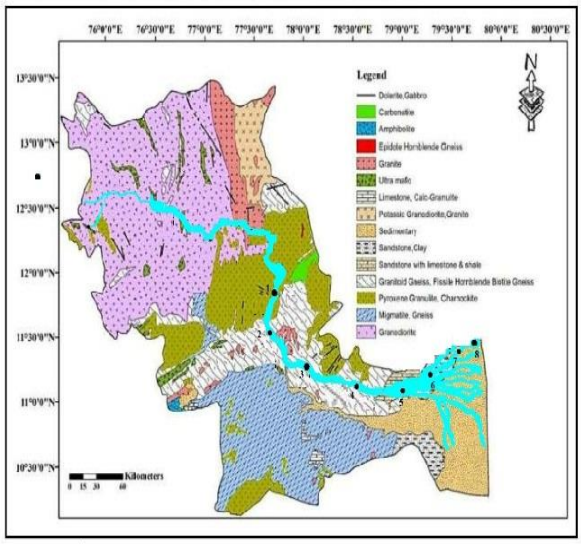

Fig.1 Geology of the area with sampling locations.

The 120 microns mesh sized sample was selected for heavy mineral separation by gravity method using heavy liquids. Ilmenites were separated with the help of stereo binocular microscope. These minerals were mounted on the slide with the help of epoxy and slightly polished and then subjected for the EPMA analysis at PPOD lab, India using Camera SX 100 EPMA instrument.

Results and Discussion

The chemistry of the ilmenite grain which were determined are shown in Table 1 and based on two oxygen atom structures, has been calculated. The TiO_2 and FeO concentration of ilmenite ranges from 46.42 to 52.18 wt%. and 46.35 to 50.68 wt% respectively. Primary ilmenite refers to unaltered grains, with composition close to the stoichiometry defined by the formula $FeTiO_3$, where TiO_2 content varies between 48 and 53 wt. %. The trilinear plot of FeO-$Fe2O_3$-TiO_2 (Fig. 3), and Scatter plot (Fig. 4a) can be inferred to show that ilmenites along the course are unaltered to slightly altered (Fig. 2). The manganese concentration is higher in grains containing 45 to 50 wt. % TiO_2 (Fig.4b). The MnO content of ilmenite ranges from 0.8% to 1.91%, and the MgO concentration varies from 0.07 to 0.85%. Magnesium is showing higher concentration when TiO_2 concentration ranges between 50-55 wt. % except in sample C5. This is due to the presence of magnesium rich rocks in the sampling site (Fig. 4c). The scatter plot (Fig. 4d) of MnO vs. MgO represents the trend in such a way that there is an increase in MgO along with decrease in MnO in ilmenites. This indicates that the source might be the basic rocks present in drainage basin. End-member compositions plotted on $FeTiO_3$-$MnTiO_3$-$MgTiO_3$-Fe_2O_3 system (modified by Nayak and Mohapatra, 1998) fall towards the ilmenite apex of the basic suites (Fig. 5). The amounts of Al_2O_3 (0.01 to 0.04%), Cr_2O_3 (0.02 to 0.1%) are recorded along the course of the river. The TiO2 concentration of ilmenite indicates that the sources of ilmenites are high grade metamorphic rocks. An ilmenite grain with TiO_2 content between 50-60% indicates their metamorphic origin for the ilmenites (Basu and Molinaroli, 1991).

Fig. 2 Microphotograph of ilmenite grains

Table 1 Showing chemical composition of Ilmenite grains.

Sample.no	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	Avg
MgO	0.72	0.28	0.07	0.22	0.14	0.85	0.48	0.75	0.43
Al2O3	0.01	0.02	0.02	0.03	0.05	0.03	0.01	0.04	0.02
Cr2O3	0.08	0.02	0.02	0.02	0.03	0.03	0.1	0.02	0.04
FeO	46.35	49.31	49.01	50.68	47.4	48.29	48.08	46.77	48.23
TiO2	52.18	48.15	49.08	46.42	51.28	49.48	50.36	51.58	49.81
MnO	0.14	0.71	1.91	1.55	0.25	0.29	0.35	0.8	0.75
FeO©	45.514	42.096	42.091	39.796	45.627	42.702	44.092	44.252	43.27
Fe2O3©	0.929	8.017	7.689	12.09	1.97	6.21	4.43	2.7	5.50
TOTAL	99.46	98.45	100.07	98.92	99.05	98.91	99.38	99.96	-
On the basis of 2 oxygen cations									
Mg	0.018	0.007	0.002	0.006	0.004	0.022	0.012	0.019	0.01
Fe	7.850	8.631	8.442	8.929	8.113	8.327	8.245	7.917	8.30
Mn	0.002	0.010	0.028	0.023	0.004	0.004	0.005	0.011	0.01
Fe2+	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.61
Fe3+	0	0.1	0.1	0.2	0	0.1	0.1	0	0.07

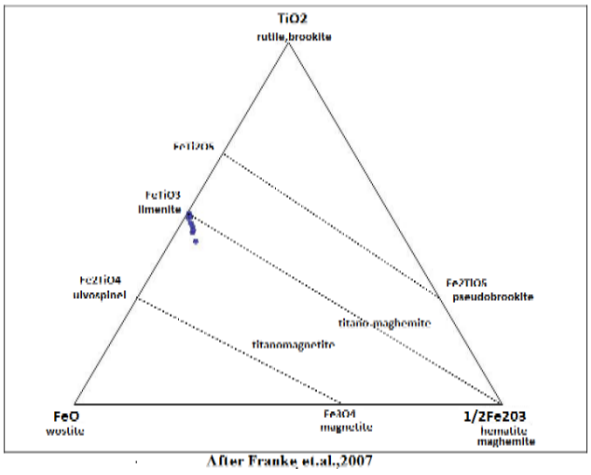

Fig. 3 Ternary diagram FeO-TiO_2-Fe_2O_3 of coexisting phases and solidus-solutions between end members under low to high temperature conditions.

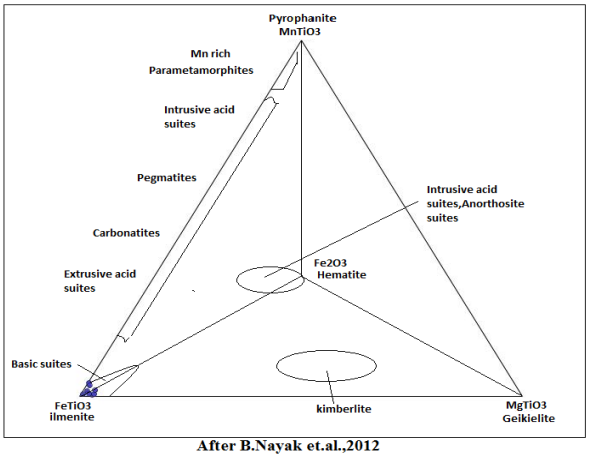

Fig. 5 Quaternary system $FeTiO_3$-Mn-TiO_3-$MgTiO_3$-Fe_2O_3 (after Nayak and Mohapatra, 1998).

Conclusion

The chemistry of ilmenite grains indicates that rocks like metabasic suites are the major source for the ilmenites in the fluvial sediments of river Cauvery.

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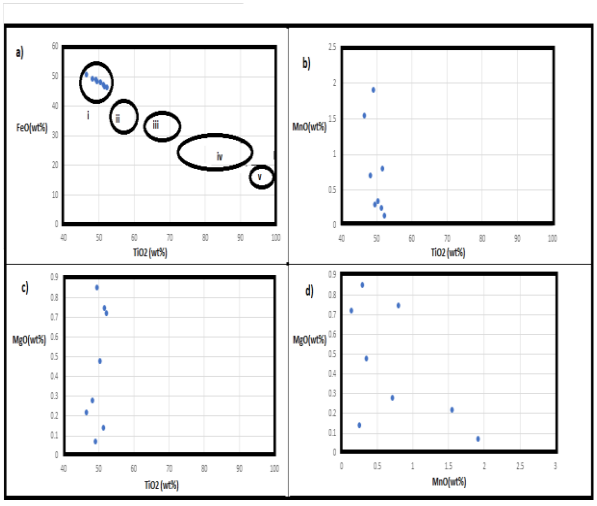

Fig. 4 X-Y scatter plots. a, b) distinct ilmenite alteration product grouped in 4 classes: unaltered ilmenite (i), hydrated ilmenite (ii), pseudorutile (iii) and leucoxene (iv). c, d, e) Mn and Mg deportment with TiO_2 increase.

References

Basu, B., Molinaroli, E. (1991). Reliability and application of detrital opaque Fe-Ti oxideminerals in provenance determination. In: Morton, A.C., Todd, S.P., Haughton, P.D.W. (eds.), *Developments in Sedimentary Provenance Studies*, **57**. Geological Society of London Special Publication, 55–65.

Darby, D. A. (1984). Trace elements in ilmenite: a way to discriminate provenance or age in coastal sands: *Geol. Soc. America Bull*, **95**, 1208-1218.

Dekov, V.M., Araujo, F., Van Grieken, R., Subramanian, V. (1997). Chemical composition of sediments and suspended matter from the Cauvery and Brahmaputra rivers India, *The Science of the Total Environment*, **22**, 89-105.

J. D. Grigsby, (1992). Chemical finger printing in detrital ilmenite: aviable alternative in provenance research, *Journal of Sedimentary Petrology*, **62** (2), 331–337.

Prakash Narasimha, K. N., Dhanya, A.V., Vybhav. K., Pradeep, P. Mujumdar, (2018), Heavy mineral chemistry studies of the Kabini river, south India: an implication for provenance, *International Journal of Research in Advent Technology*, **6**, 1191-1196.

Nayak, B. R., Mohapatra, B. K. (1998). Two morphologies of pyrophanite in Mn-rich assembl ages, Gangpur Group, India. *Mineral Mag*, **62**, 847-856.

Sukumaran P. V., Nambiar, A. R. (1994). Geochemistry of ilmenite from Ratnagiri coast, Maharashtra, *Current Science*, **67** (2), 105–106.

Pettijohn, F. J., Potter, P. E., Smvtm, R. (1987). Sand and Sandstone, 2nd edition: New York, Spfinger-Verlag, 553 pages.

Pichamuthu, C. S. (1976). Some problems pertaining to the Peninsular Gneiss Complex. *J. Geol. Soc. India*, **17**, 1–16.

Pichamuthu, C. S. (1978). Archaean Geology investigations in southern India. *Geol. Soc. India*, **19** (10), 431–439.

Pownceby, M. I., Fisher-White, M. J. (1999). Phase equilibria in the systems Fe_2O_3-MgO-TiO_2 and FeO-MgO-TiO_2 between 1173 and 1473 K, and Fe2+ -Mg mixing properties of ilmenite, ferrous spseudobrookite and ulvospinel solid solutions. *Contributions to Mineralogy and Petrology*. **135** (2-3), 198-211.

Prakash Narasimha K. N., Schoichi Kobayashi, K., Tetsuya Shoji., Munetake Sasaki, Sethumadhav, M.S., (2009). XRD, EPMA and FTIR studies on garnet from Bettadabidu, Sargur area, Karnataka, India, *Journal of Applied Geochemistry*, **11** (1), 1-11.

Ramakrishna, M., Swaminath, J. (2009). Tectonics and crustal evolution, *Geol. Surv. India*, Mem, **112**, 261-271.

Ramdohr, P. (1980). Ore minerals and their intergrowth (2nd edition), New York, Pergamon Press, 1205 pages.

Subramanian, K.S., Selvan, T. A. (2001), Geology of Tamil Nadu and Pondicherry,1st edition. *Geological Society of India*, Bangalore, 192 pages.

Sundaram R., Rao, P. S. (1981). Lithostratigraphy of Cretaceous and Palaeocene rocks of Tiruchirapalli district, Tamil Nadu, South India. *GSI Rec* **115** (5), 9–23.

V. S. Hegde, G. Shalini, and D. Gosavi Kanchanagouri, (2006). Provenance of heavy minerals with special reference to ilmenite of the Honnavar beach, central west coast of India, *Current Science*, **91(**5), 644–648.