Geochemistry of ilmenite from Ratnagiri coast, Maharashtra

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The well-known heavy mineral placers of Ratnagiri beaches and offshore areas are ilmenite rich; they are almost free from monazite, zircon, sillimanite and rutile. The ilmenite has TiO_2 content close to theoretical TiO_2 values in the mineral. Though very fine in size (3.5 phi), they are comparable to the ilmenites of Quilon beach in their trace element abundances and this may not be a discouraging factor in utilizing them for pigment manufacture.

THE ilmenite placers of the Konkan coast of Maharashtra are well known[1–4]. In order to establish the offshore extension of these beach placers, the Geological Survey of India undertook two cruises (SS-84 and SS-91) in Kalbadevi bay, and Ratnagiri and Mirya bays respectively on board their coastal vessel Samudra Shaudhikama during 1987–88 and 1988–89 field seasons. Ilmenite reaches a grade of 40% in Kalbadevi bay sediments and 29% in Ratnagiri bay sediments. Mirya bay sediments are leaner, containing only up to 14% ilmenite. The chief other heavy minerals in the placer are magnetite and pyroxenes. They are almost free from monazite, sillimanite zircon and rutile. In order to utilize these resources it is important to know their trace element chemistry, especially their Co, Ni, Cr and V abundances, as higher abundances of these elements in ilmenite make them unsuitable in pigment industry.

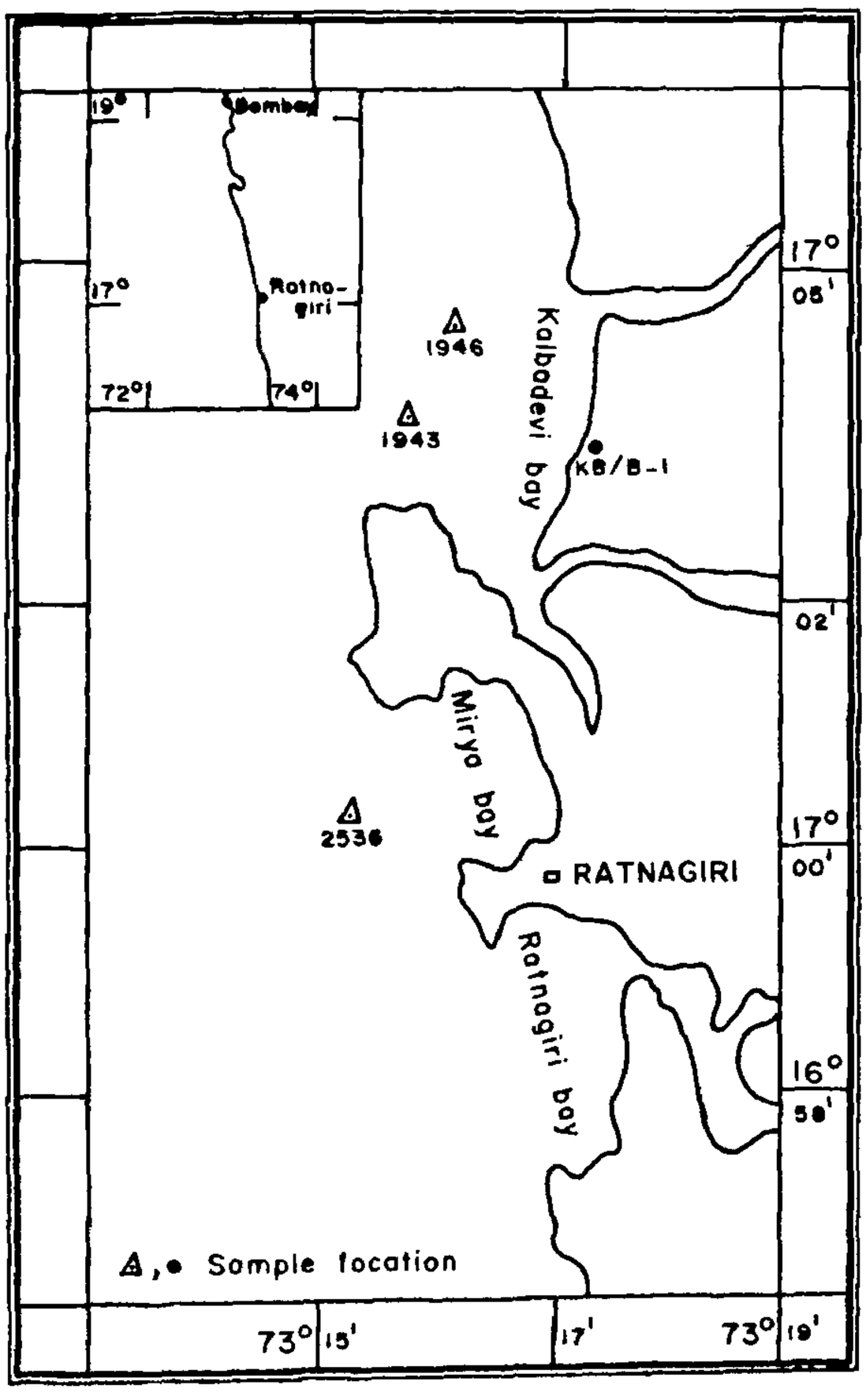

Figure 1. Map showing location of samples.

Representative samples from the beach and offshore areas (Figure 1) were concentrated by separation with bromoform (sp. gr. 2.87) and by repeated separation of magnetite with a hand magnet. The sample was then run through the isodynamic separator at 0.275 amperes several times to isolate ilmenite from other heavy minerals. The purity of the final ilmenite separate was ensured to be about 98% by examining the sample under a binocular microscope.

The samples were analysed at the Central Chemical Laboratory of the Geological Survey of India at Calcutta. Two samples from Honnawar beach and one from the well-known Chavara beach were also analysed for comparison. The analytical results are given in Table 1. The analytical results of 'Q' grade ilmenite of Indian Rare Earths Ltd., Chavara are also given in the table.

The Ratnagiri ilmenites have an average TiO_2 of 52.80%. This is close to the theoretical limit of 52.75% TiO_2 in ilmenite[5]. The ilmenites of Honnawar beach in comparison are lower in TiO_2, while those of Quilon (Chavara–Neendakara sector) are higher. The higher TiO_2 (often higher than the theoretical TiO_2 in ilmenites) of Quilon ilmenites may be due to the different degree of alteration of ilmenite to leucoxene and/or due to tiny inclusions of abundant rutile in ilmenite[6–9]. On the contrary, the Ratnagiri ilmenites do not exhibit pronounced alteration to leucoxene. The Ratnagiri ilmenites also analyse trace amounts of Al, Ca, Mg and Na. Although Mg can enter ilmenite structure[5], the other constituents appear to be from negligible amounts of impurities like pyroxene and plagioclase present in the sample.

The Cr, V and Mn contents of Ratnagiri ilmenites are comparable to those of Quilon ilmenites. Mn is slightly lower than Quilon ilmenites while Cr and V are only marginally lower. In comparison the Honnawar samples show higher Mn by a factor of four, whereas V, Co and Ni values are distinctly lower than Ratnagiri and Quilon samples. Co and Ni in Ratnagiri ilmenites are remarkably higher than Chavara and Honnawar samples. Nb and Ta are less than 100 ppm and zinc does not show much variation.

Table 1. Chemical composition of ilmenites

Sl No	Sample no	TiO_2 (%)	FeO* (%)	Co (ppm)	Cr (ppm)	V (ppm)	Mn (ppm)	Ni (ppm)	Zn (ppm)
1	84/1943–5	51 25	43 79	194	621	872	2107	84	232
2	84/1946–6	56 25	37.50	178	773	791	2057	93	197
3	84/1946–17	50 00	45 08	93	513	661	2210	78	179
4	84/1946–19	53 13	42.55	153	583	811	2218	94	208
5	91/2536–1	51 25	40 64	153	724	875	2189	82	223
6	91/2536–18	53 13	41 47	123	740	849	2344	87	235
7	84/KB/B–1	54 38	40 95	114	508	738	2228	86	207
8	B–1	50 63	42.76	29	514	100	8891	–	316
9	B–3	49 34	43 48	34	1731	120	11769	19	242
10	C–1	57 50	37 43	9	1106	537	2491	13	211
11	'Q'	60 60	30.01	–	821	840	–	–	–

Sl No 1–4 and 7 Kalbadevi beach and bay samples
Sl. No 5 and 6 Ratnagiri bay samples
Sl No 8 and 9 Honnawar beach samples
Sl No 10 Chavara beach sample
Sl. No. 11 'Q' grade ilmenite of Quilon sector (Indian Rare Earths Ltd , Chavara)
*Total Fe as FeO.

Published trace element data on Ratnagiri ilmenites are rare. Sethna *et al.*[10] reported electron microprobe data of ilmenites and magnetites from Deccan Basalts of Igatpuri and Mahabaleshwar areas and concluded that there are no pure ilmenite or magnetite phases (ilmenite containing 3.03% to 12.59% hematite molecule and magnetite containing 36.06% to as high as 90.53% ulvospinel molecule). These authors did not report V in their samples although Cr_2O_3 is reported to vary from 0.16% to 0.29% in the ilmenite. Ali *et al.*[4] reported 52.5% TiO_2 and 0.05% Cr_2O_3 and 0.13% V_2O_5 for a sample of ilmenite from Kalbadevi beach. Our results are broadly in agreement with those of Ali *et al.*[4].

From the above data it appears that the ilmenites of both Ratnagiri and Quilon coasts are comparable both in their major and trace element composition except in the elevated TiO_2 contents of the latter which may be due to reasons mentioned above. The titanium contents of igneous rocks decrease with silicon content[11]. Basic rocks can therefore contain more ilmenite than acidic rocks and ilmenite of basic rocks can incorporate more of Cr, Co, Ni and V than ilmenite from acidic rocks. The Ratnagiri ilmenites are basalt-derived and so their higher concentrations in these elements are inherited from a basic parent magma. Elevated abundances of these siderophile elements in the Quilon ilmenites suggest that basic rocks like amphibolites and pyroxene granulites present in abundance as restites in charnockite terrain of Kerala[12] are the chief sources of ilmenite of Quilon. The very high abundance of Mn and low amounts of Co, V and Ni in the ilmenite of Honnawar may indicate the source of ilmenite primarily from manganiferous metasediments and acidic rocks rather than from mafic rocks.

In conclusion, ilmenites of Ratnagiri coast have TiO_2 approaching the theoretical TiO_2 contents in ilmenite. They show higher abundances of Co and Ni, and somewhat similar concentrations of Mn, Cr and V with that of Quilon ilmenites. The data show that their trace element abundances may not be a discouraging factor in utilizing them for pigment manufacture, although their fine size may be a deterrent.

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