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Results of a CCSEM study of coastal sediments,  
with particular emphasis on compositional  
distribution of ilmenite and garnet

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# 1. Abstract

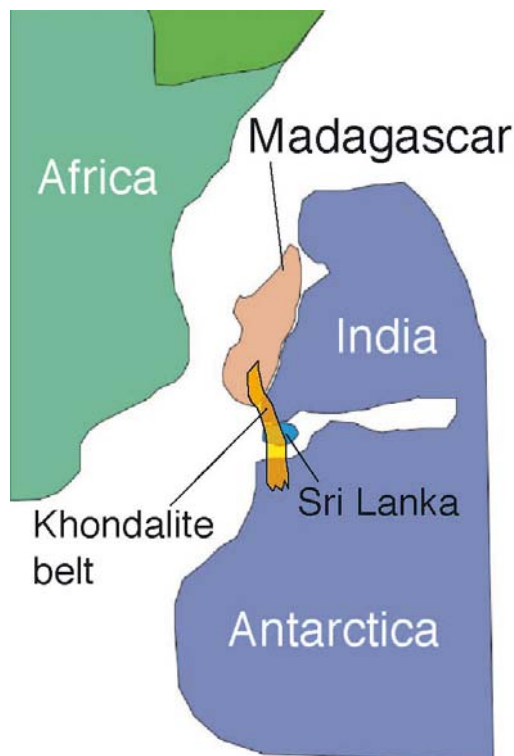
A sampling programme in southern Madagascar was conducted in order to explore for new high-Ti ilmenite deposits in geological environments similar to that of the high-Ti ilmenite deposits in beach sands of SW India. A total of 40 samples were collected over about 700km of coast line. Half of the samples were taken from coastal sediments proximal to a belt of high-grade metasediments, exposed in the eastern part of southern Madagascar, and which resembles the khondalite belt of Kerala State in SW India. The remaining samples were taken from mainly coastal sediments in the western part of southern Madagascar. The sediments represented by these samples come from a large, long-lived (>500my) sedimentary basin.

The results of the study show that:

- Nearly all samples adjacent to the Madagascar khondalites ('eastern Madagascar') contain a high proportion of ilmenite with elevated  $\text{TiO}_2$ , and 5 samples have average  $\text{TiO}_2$  in ilmenite between 60 and 64 wt. %.
- The distribution of  $\text{TiO}_2$  in ilmenite grains is distinctly bimodal in most samples from eastern Madagascar, pointing to several sources of ilmenite in the sediments.
- In the high-Ti samples (average ilmenite  $\text{TiO}_2 > 60$  wt. %), the distribution of  $\text{TiO}_2$  in ilmenite is unimodal with narrow ranges in  $\text{TiO}_2$ .
- Samples adjacent to the large sedimentary basin ('western Madagascar') have average ilmenite with  $\text{TiO}_2$  in the range 51-55 wt. %. Some samples have strongly bimodal distribution of  $\text{TiO}_2$  in ilmenite, and in at least one place the high-Ti ilmenite population points to a 'fossil' Ti-enhanced ilmenite deposit (sample 68).
- There is evidence that leaching of ilmenite is an ongoing process in at least one site around Fort Dauphin in eastern Madagascar (sample 55).
- Average ilmenite and garnet compositions in samples from the high-Ti samples are identical to those of samples with high-Ti ilmenite from India.
- The combination of geological information (maps etc) and garnet/ilmenite chemistry thus proves to be an efficient tool in outlining new high-grade ilmenite deposits world wide.

## 2. Introduction

Studies of high-Ti ilmenite deposits in SW India have suggested that their source rocks are found within the Kerala khondalite belt (Soman, 1985; Bernstein 2003, 2004). Khondalites comprise aluminium-rich rocks, usually metasediments, which have undergone granulite facies metamorphism. The term usually covers regions dominated by garnet, sillimanite, graphite, biotite ilmenite bearing schists, but the regions often also contain slivers of charnockites and mafic lithologies, such as two pyroxene metagabbros. A study by Bernstein (2004) further constrains the source rocks of the Indian high-Ti ilmenite deposits to be sillimanite-bearing, garnet-rich lithologies, whereas orthopyroxene-bearing lithologies are less likely to yield material to the deposits. With this knowledge, and in the search for global Ti-rich ilmenite deposits, it was decided to look for other occurrences of khondalite rocks within the 35°N and 35°S belt which have been identified as the climatic region being of particular interest with regard to recent leaching of ilmenite (e. g. Force, 1991). Palaeo-reconstruction of plateconfigurations (Fig. 1) shows that prior to the break-up of Gondwanaland, the belt of khondalites, presently exposed in southern India, stretched across Sri Lanka to the eastern side of India, and into Madagascar to the other side of India. After the location of the khondalite belt in Madagascar was identified, a sampling programme was designed in order to test the hypothesis of khondalites being a source of easily weathered ilmenite, and in order to delineate new potential high-Ti ilmenite sand deposits.



**Figure 1.** *Reconstruction of palaeo-plates at ca. 140 Ma (after de Wit, 2003), showing the close association of Madagascar, India and Sri Lanka prior to continental break-up. The khondalite belt extends across all three continental fragments and into Antarctica.*

### 3. Geological outline

The eastern part of southern Madagascar comprises a series of Precambrian basement rocks which underwent high-grade metamorphism during the late stages of the Panafrican orogeny (Fig. 2). Metamorphic ages are around 600 my, thus straddling the Proterozoic-Palaeozoic boundary (de Wit, 2003). The gneisses were metamorphosed in upper amphibolite to granulite facies (Nicollet, 1990), and subsequently intruded by synorogenic granitoid bodies. The eastern edge of the island is rimmed by Mesozoic volcanic rocks, mainly basalts, erupted during the continental break-up that led to the separation of Madagascar from the Seychelles. In the central highlands of southern Madagascar is also found a large volcanic structure, Volcan de l'Androy, which is linked to the Mesozoic break-up in the presence of the Marion hot-spot (Storey et al., 1997). To the west, the basement rocks are covered by late Paleozoic to recent sedimentary rocks of terrestrial (oldest) and marine origin.

The lithologies of interest as source rocks for potential high-Ti ilmenite are the high-grade metamorphic paragneisses of southern Madagascar, and which are exposed as a >200km wide tract wedging out to the north and about 400 km in north-south dimension. The main interest concerns the cordierite schists (A1) as represented by the geological map (Besairie, 1965, and Fig. 2).

In order to evaluate the Ti potential of ilmenite from sediments around southern Madagascar, a sampling programme was initiated. The programme was conducted by consultant geologist Rasmus Christensen (see appendix 1). In about three weeks time Christensen collected a 0.5 kg sediment sample at about 20km spacing from Manambondro to about 50km west of Fort Dauphin, and at 40km spacing from 50km west of Fort Dauphin to Tuléar on the west coast of southern Madagascar. The total length of coastline covered is about 700km, and a total of 40 samples were collected.

Figure 2.

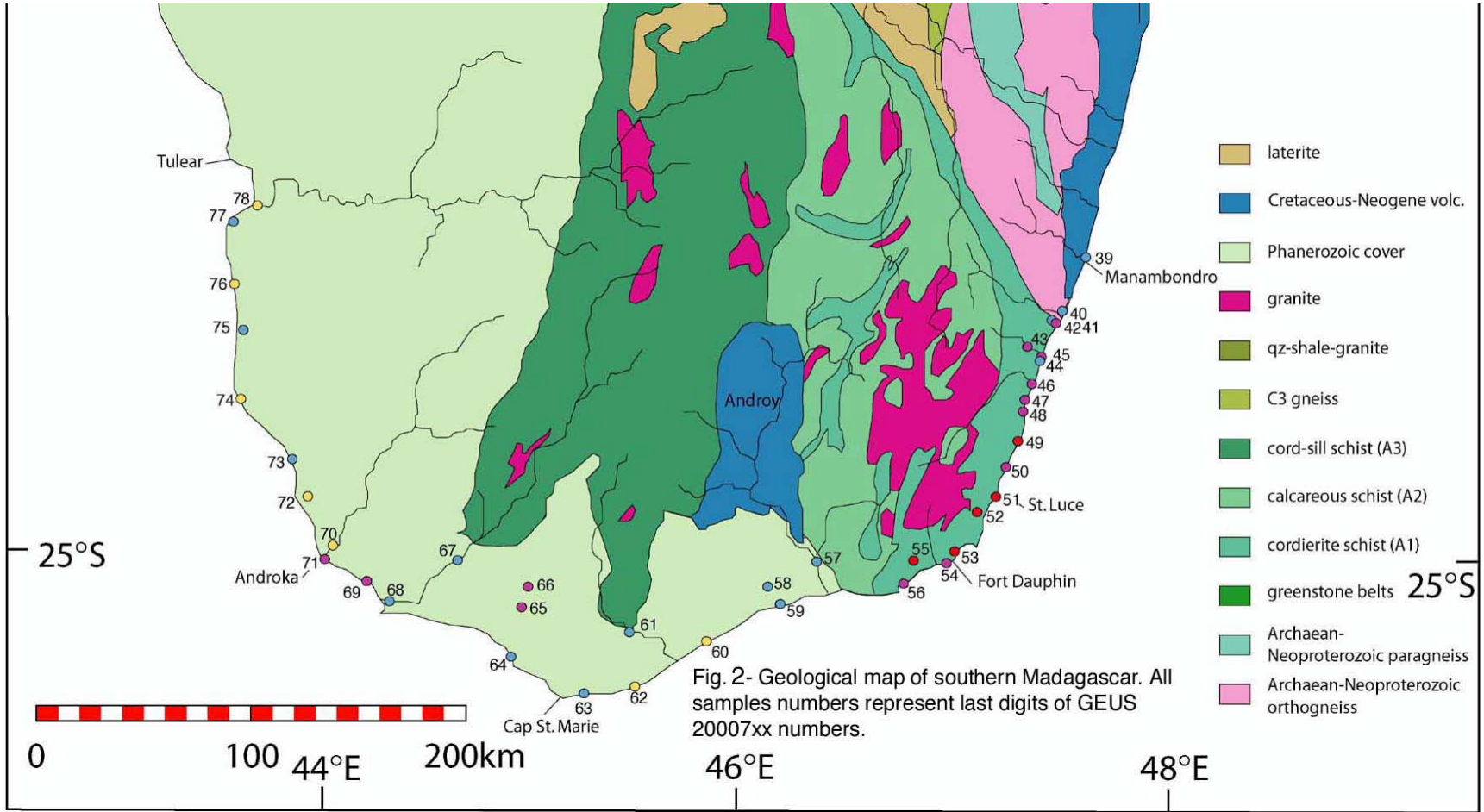


Fig. 2- Geological map of southern Madagascar. All samples numbers represent last digits of GEUS 20007xx numbers.

## 4. Sample processing and analyses

All sediment samples were processed as follows: depending on the visual contents of heavy minerals, 30 to 90 grammes of sediment was split from the bulk, dried and washed on a 45 micrometer sieve. The fraction larger than 45 micrometer was then sieved through 710 micrometer screen and the fraction between 45 and 710 micrometer was passed through a centrifuge in  $\text{CHBr}_3$  with a density of 2.8 gr/cc. The heavy mineral fraction was then mounted in epoxy, cut to a thickness of ca. 200 micrometer, and polished for CCSEM analysis. All fractions are weighted. The CCSEM analyses were conducted using the standard routines developed at the Department of Geological Mapping at GEUS. About 600 grains were analysed in each sample.

For bulk XRF analysis, a 30 grammes split was crushed in tungsten-carbide mortar. About 2 grammes of the powder was pressed into pellets and run by a PANalytical MagiX PRO spectrometer at the Geological Institute, University of Copenhagen. The reported major element analyses have been calibrated against a series of sediment samples run by the major element XRF laboratory at GEUS on fused glass discs. XRF data on all 40 samples will be reported in 2005 Madagascar Report to DuPont.

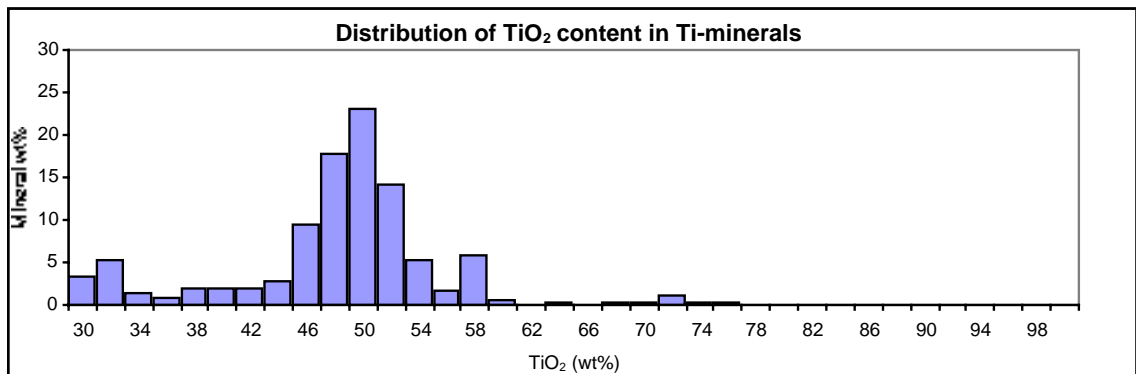


## 5. Results and discussion

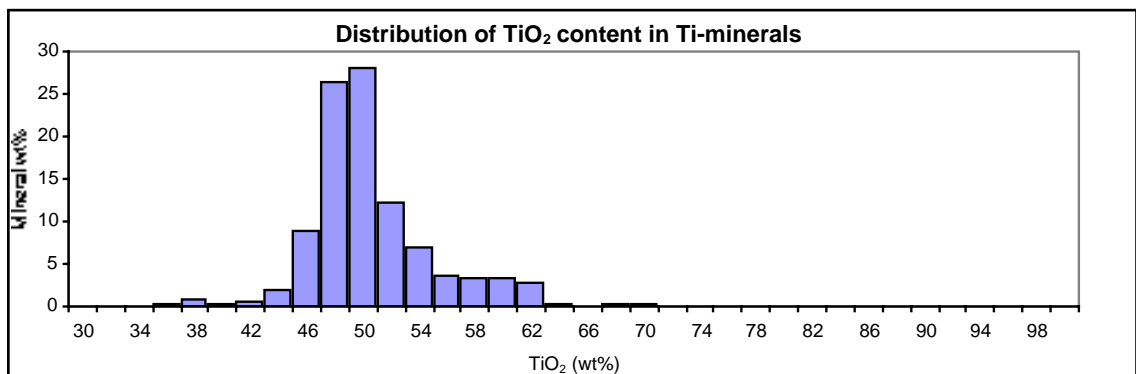
### 5.1 Distribution of TiO<sub>2</sub> in titanium-bearing minerals

In short, CCSEM analyses show that 13 of the samples were found to have ilmenite with average TiO<sub>2</sub> between 54.6 and 57.9 wt. %, and these will in the following be referred to as 'intermediate-Ti' samples. Five samples were found to have ilmenite with average TiO<sub>2</sub> > 60 wt. % ( 60.5 - 64 wt. %), and these samples will be referred to as 'high-Ti' samples. The remaining 15 samples have TiO<sub>2</sub> in average ilmenite of between 50 and 53.6 wt. % and will be referred to as 'low-Ti' samples.

The five high-Ti samples come from a relatively large stretch of coast from north of St. Luce, over some 80km towards the south and a bit west of Fort Dauphin. Most of the intermediate-Ti samples come from the same region, but extend further 60 km to the north along the coast towards Manambondro. The remaining samples, from around Manambondro and along the southwest coast from Fort Dauphin belong to the low-Ti group. Exceptions to this is a series of samples (65, 66, 69, and 71) that all come from a region around the town of Androka, and which have elevated Ti in average ilmenite.

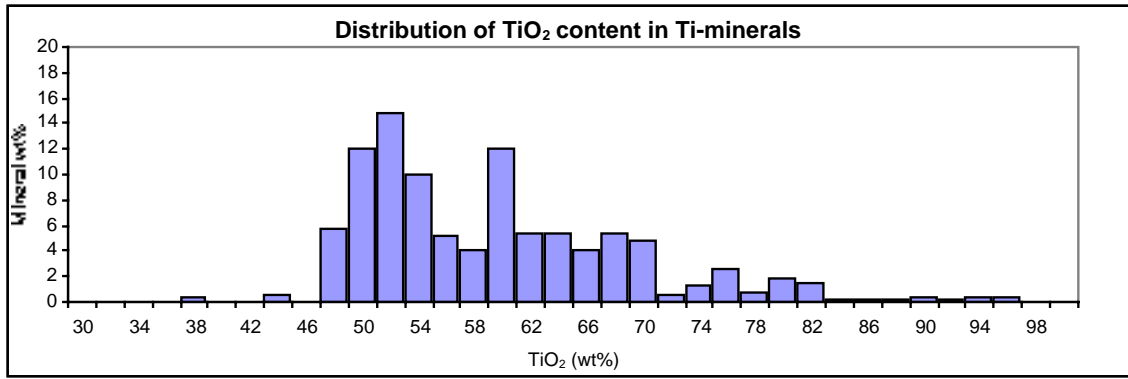


2000739 Average TiO<sub>2</sub> in ilmenite: 51.04

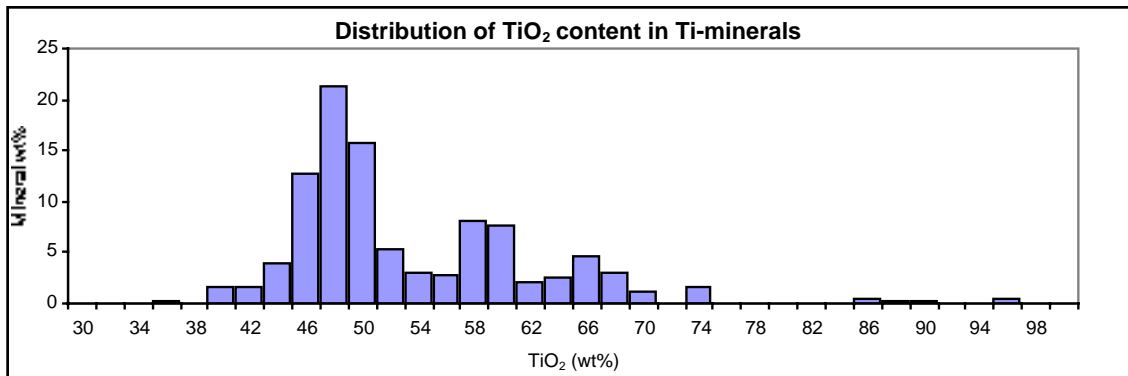


2000740 Average TiO<sub>2</sub> in ilmenite: 51.10

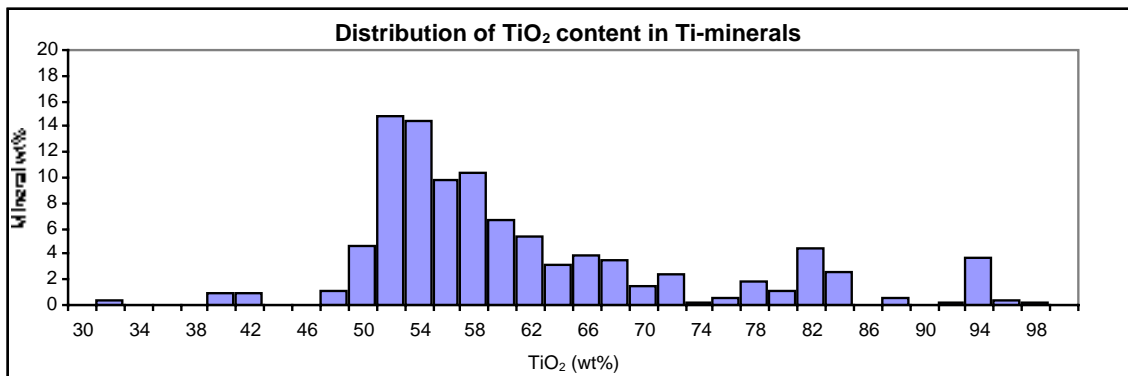
**Figure 3.** Distribution of TiO<sub>2</sub> in titanium minerals in individual samples.



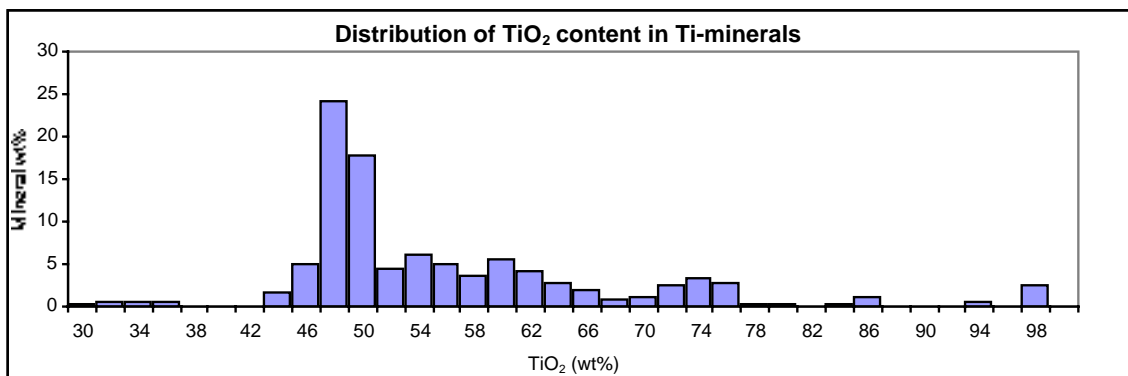
2000741 Average TiO<sub>2</sub> in ilmenite: 56.49



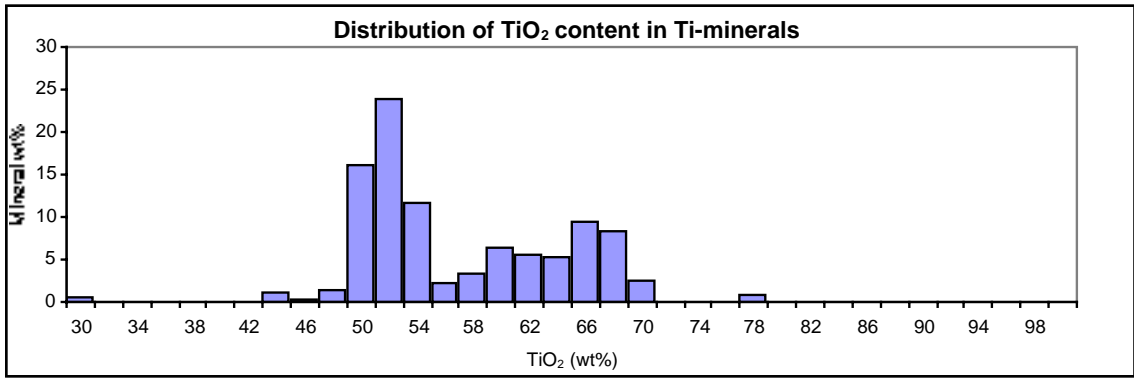
2000742 Average TiO<sub>2</sub> in ilmenite: 52.48



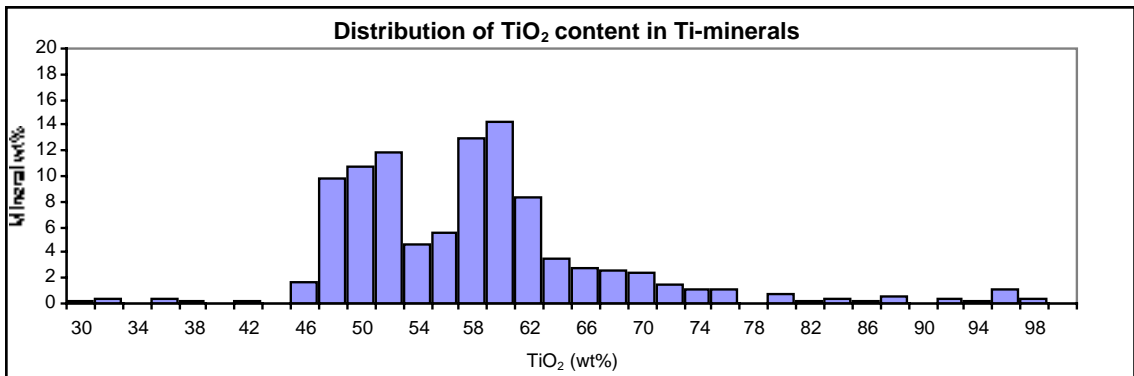
2000743 Average TiO<sub>2</sub> in ilmenite: 56.60



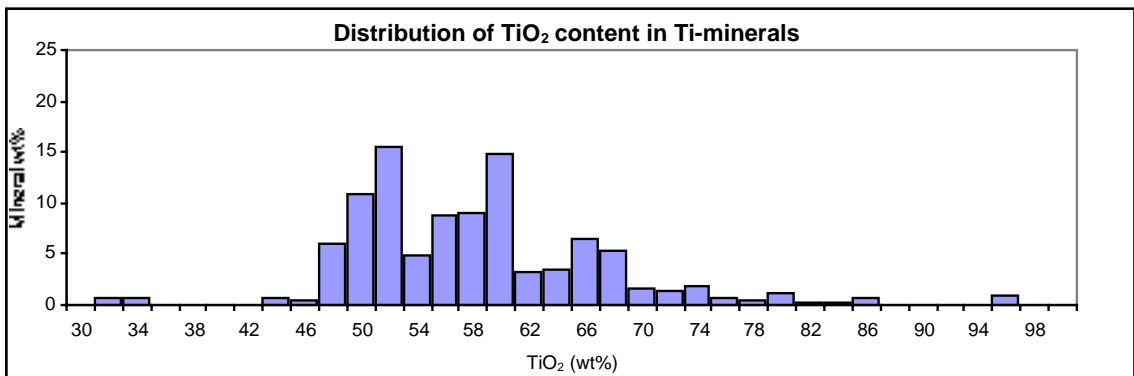
2000744 Average TiO<sub>2</sub> in ilmenite: 52.48



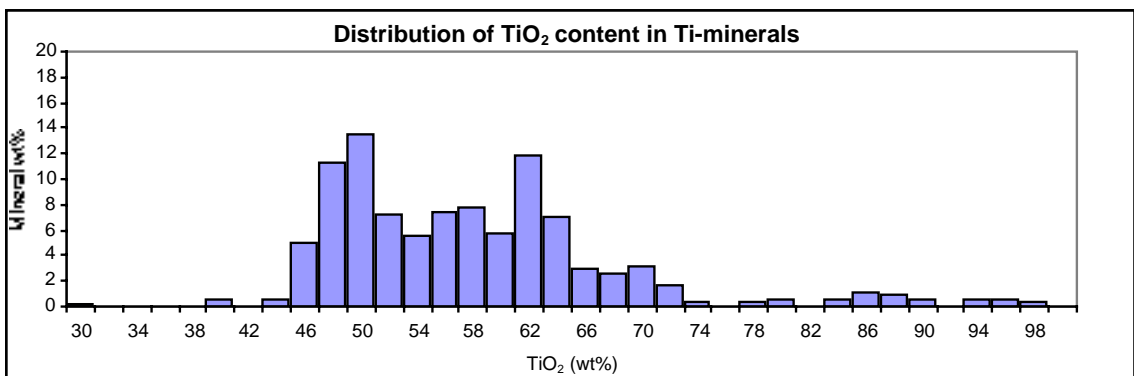
2000745 Average TiO<sub>2</sub> in ilmenite: 54.50



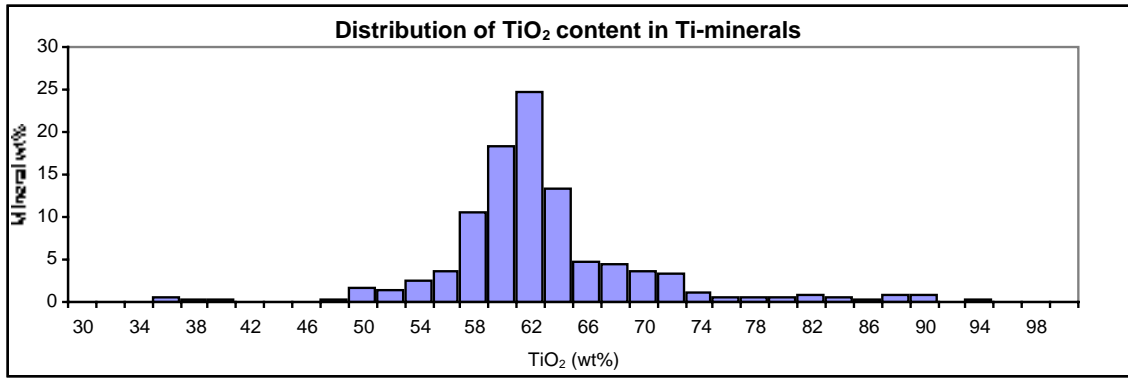
2000746 Average TiO<sub>2</sub> in ilmenite: 55.37



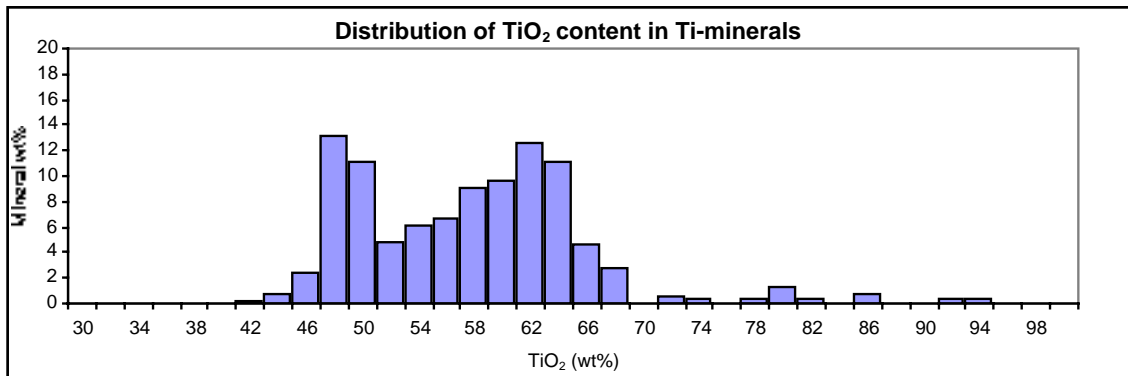
2000747 Average TiO<sub>2</sub> in ilmenite: 55.63



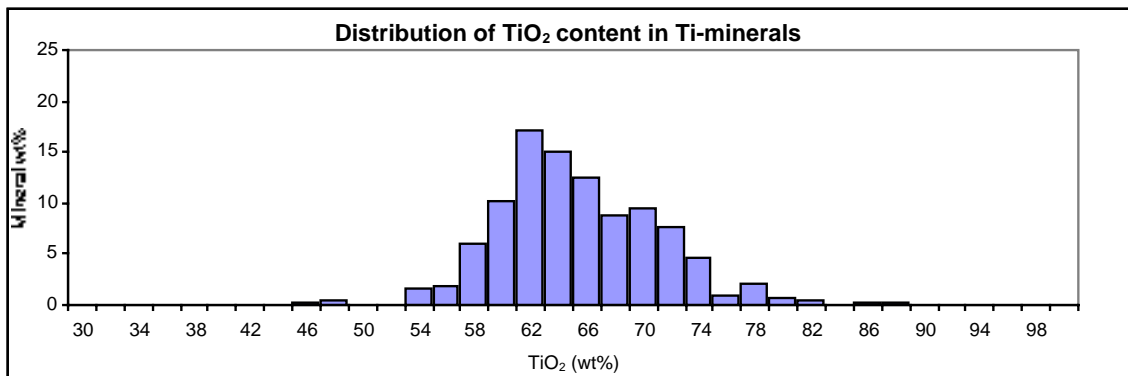
2000748 Average TiO<sub>2</sub> in ilmenite: 55.10



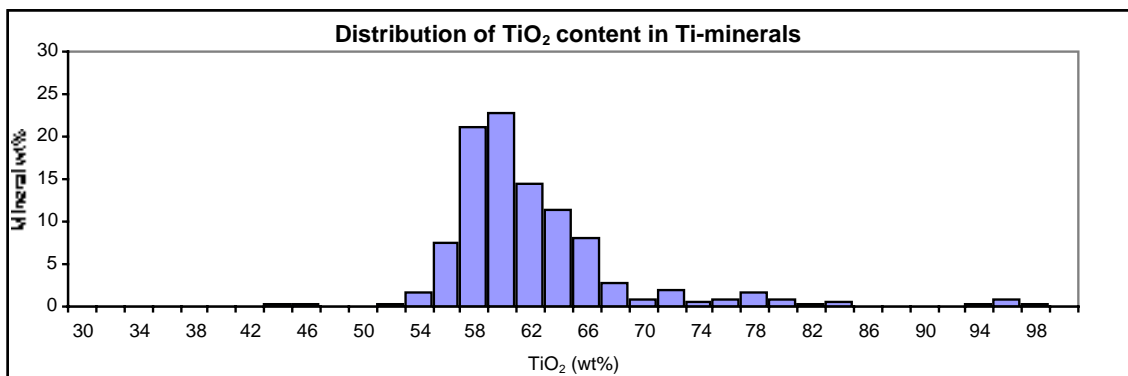
2000749 Average TiO<sub>2</sub> in ilmenite: 60.49



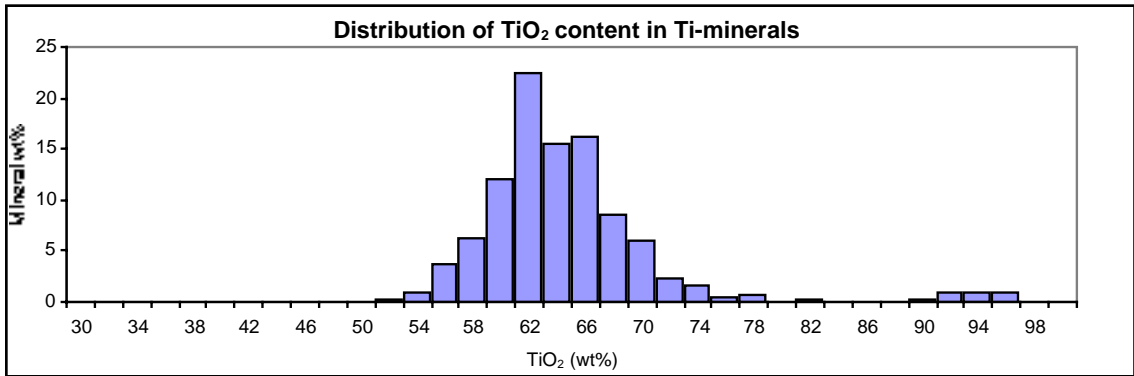
2000750 Average TiO<sub>2</sub> in ilmenite: 55.72



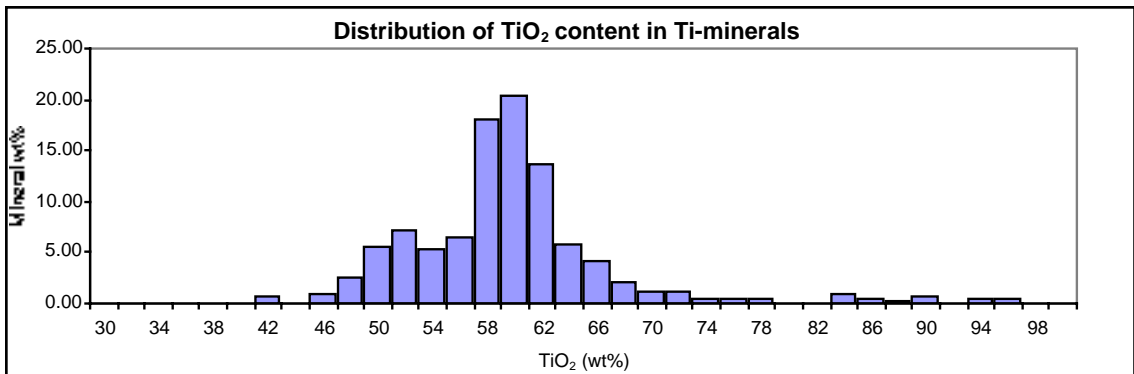
2000751 Average TiO<sub>2</sub> in ilmenite: 62.79



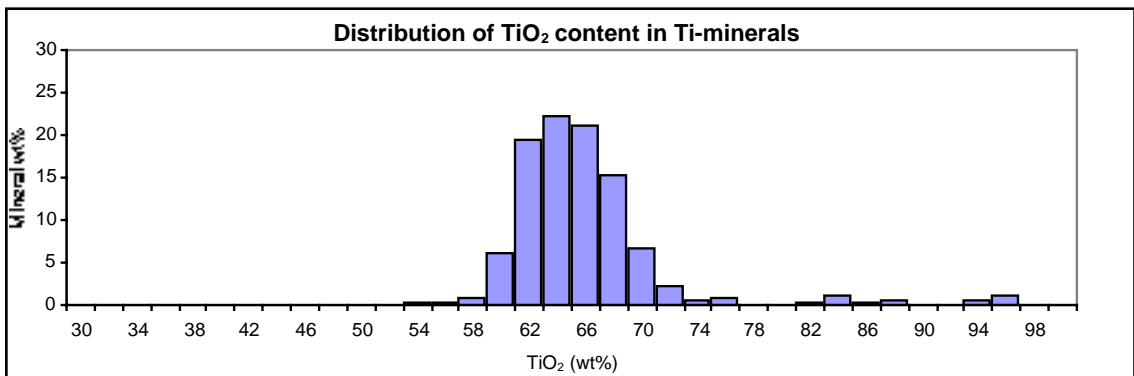
2000752 Average TiO<sub>2</sub> in ilmenite: 60.75



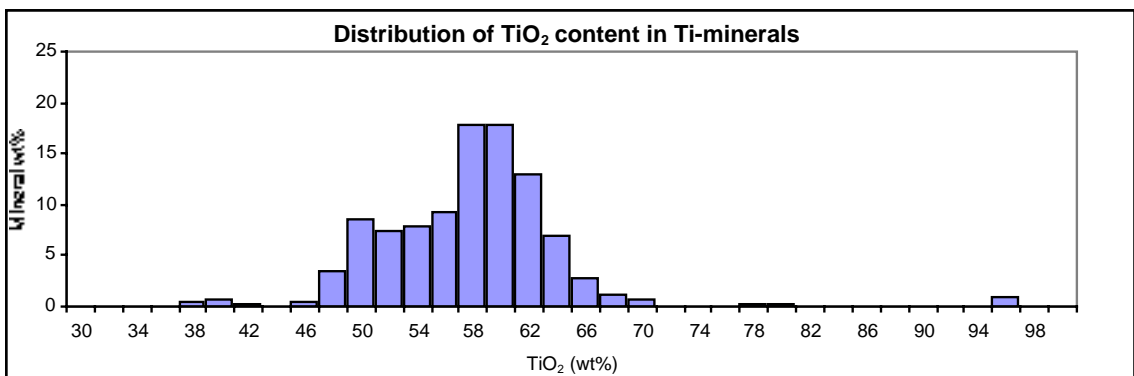
2000753 Average TiO<sub>2</sub> in ilmenite: 62.49



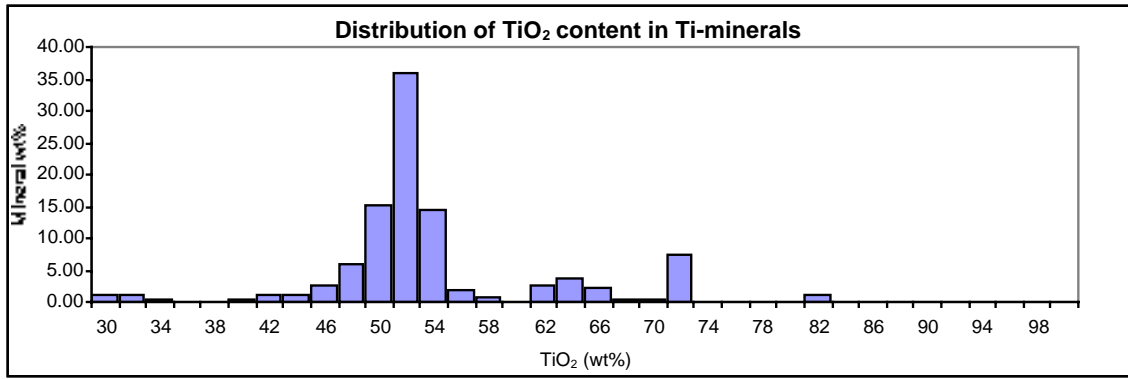
2000754 Average TiO<sub>2</sub> in ilmenite: 57.85



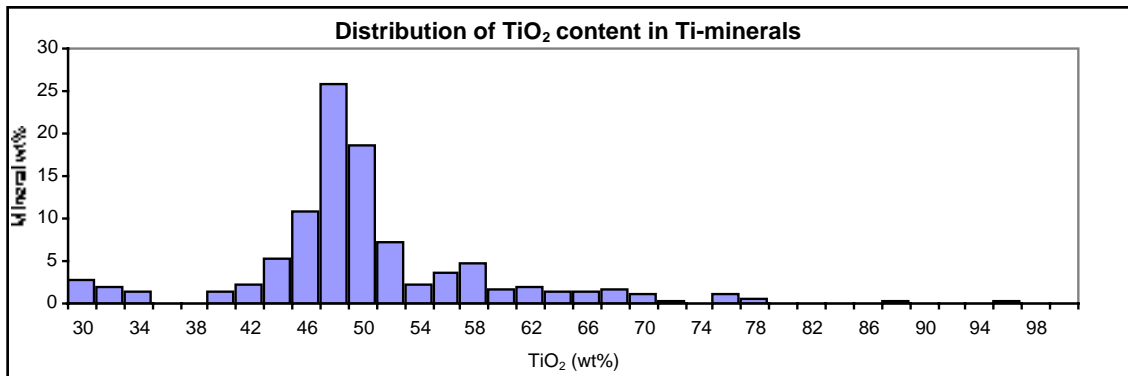
2000755 Average TiO<sub>2</sub> in ilmenite: 64.01



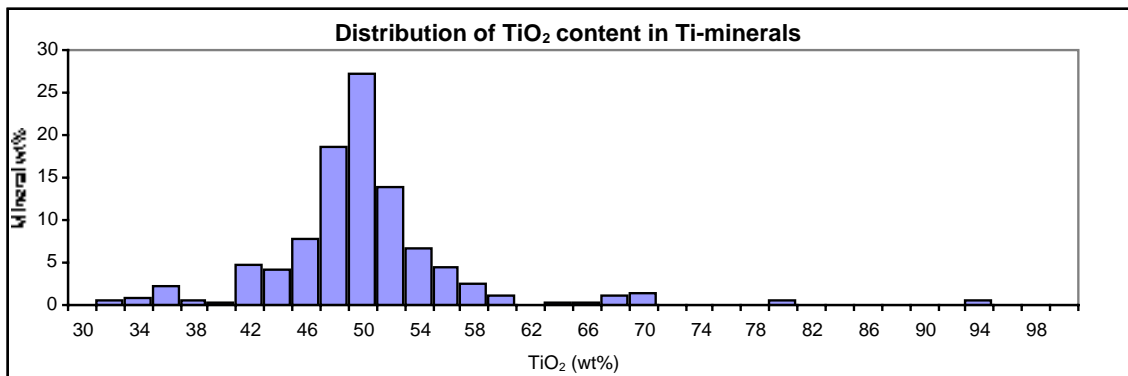
2000756 Average TiO<sub>2</sub> in ilmenite: 57.31



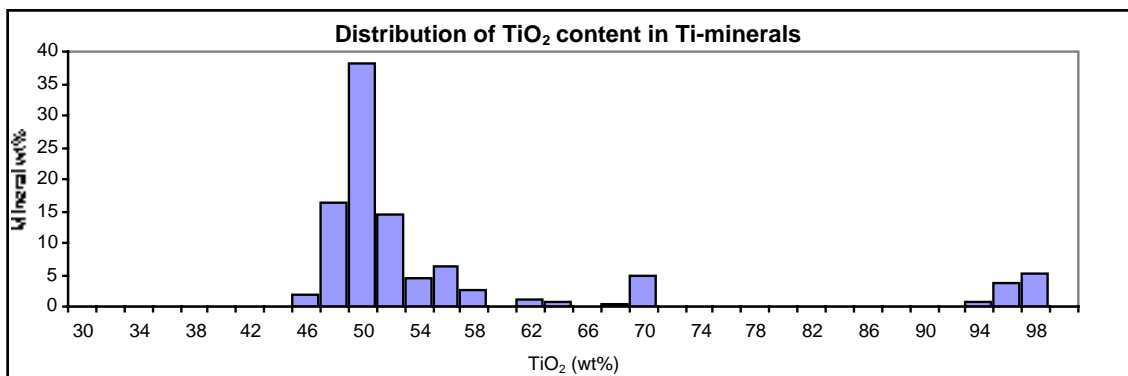
2000757 Average TiO<sub>2</sub> in ilmenite: 52.54



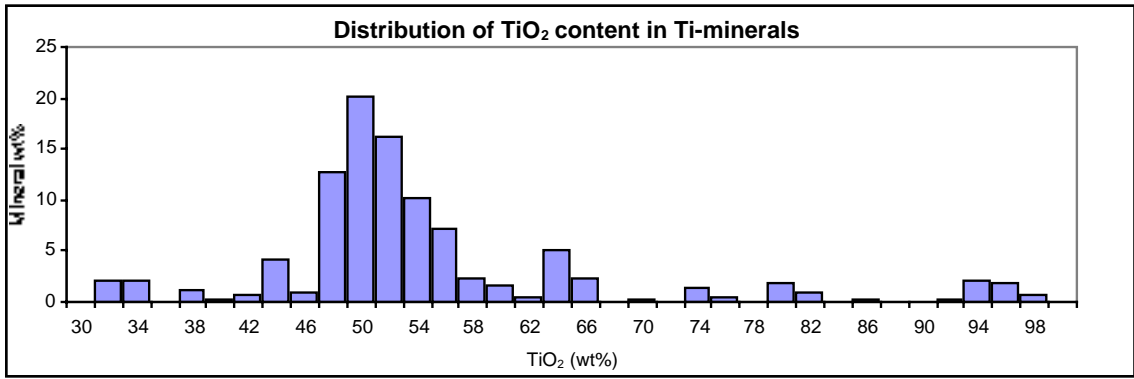
2000758 Average TiO<sub>2</sub> in ilmenite: 51.56



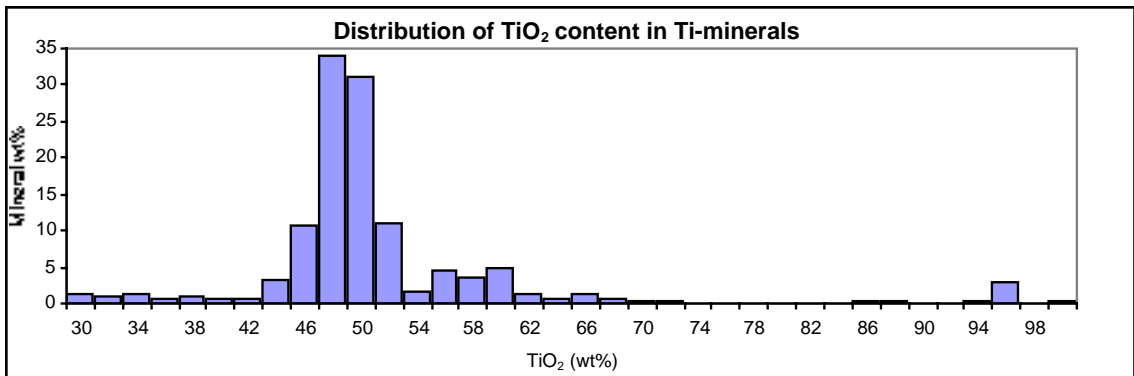
2000759 Average TiO<sub>2</sub> in ilmenite: 50.52



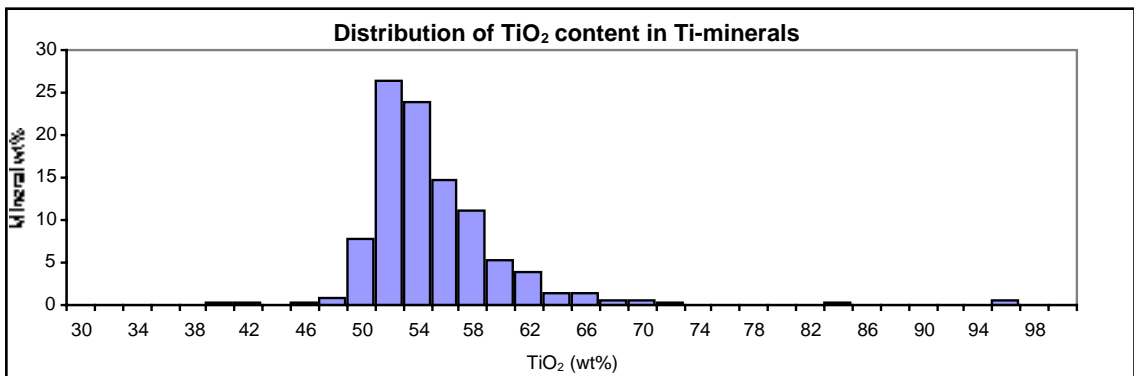
2000761 Average TiO<sub>2</sub> in ilmenite: 52.30



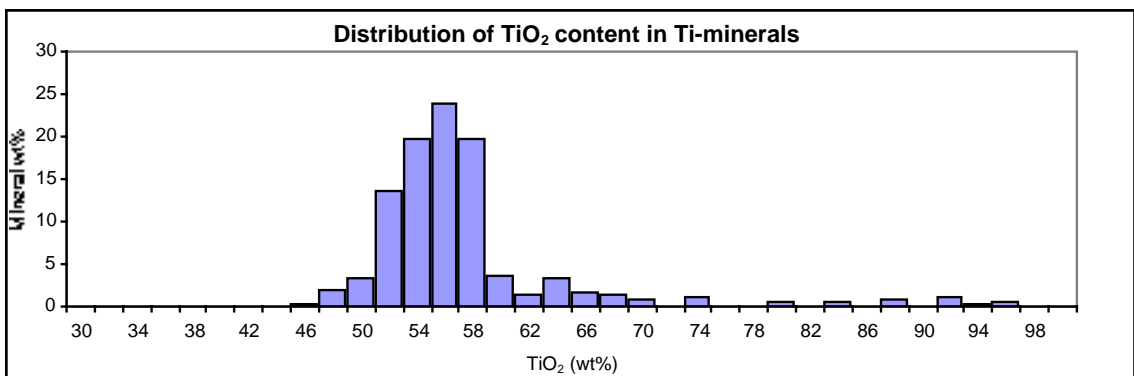
2000763 Average TiO<sub>2</sub> in ilmenite: 52.6



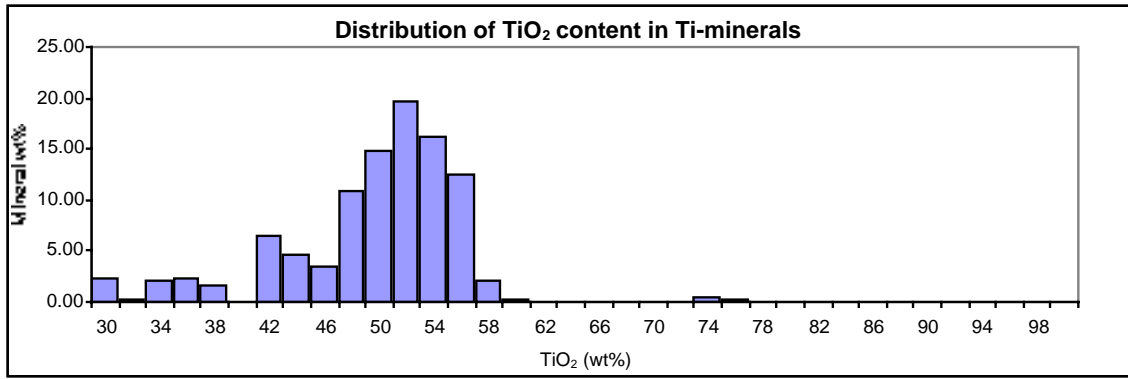
2000764 Average TiO<sub>2</sub> in ilmenite: 51.09



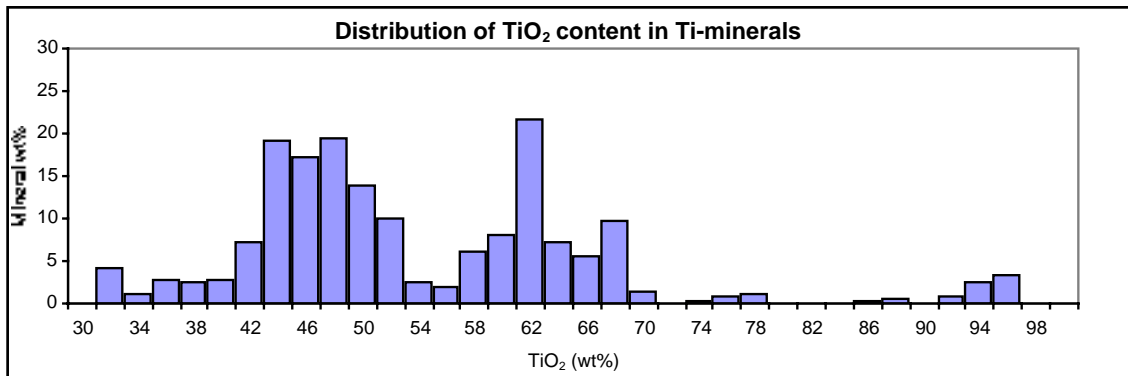
2000765 Average TiO<sub>2</sub> in ilmenite: 55.02



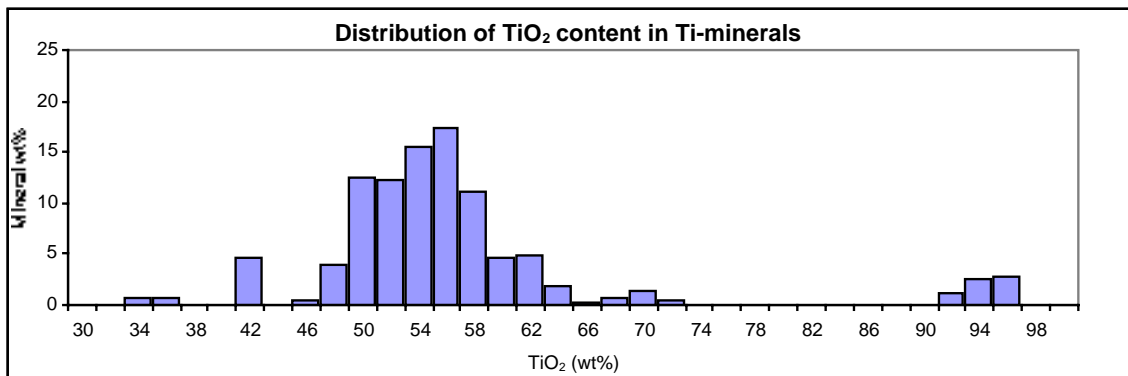
2000766 Average TiO<sub>2</sub> in ilmenite: 54.96



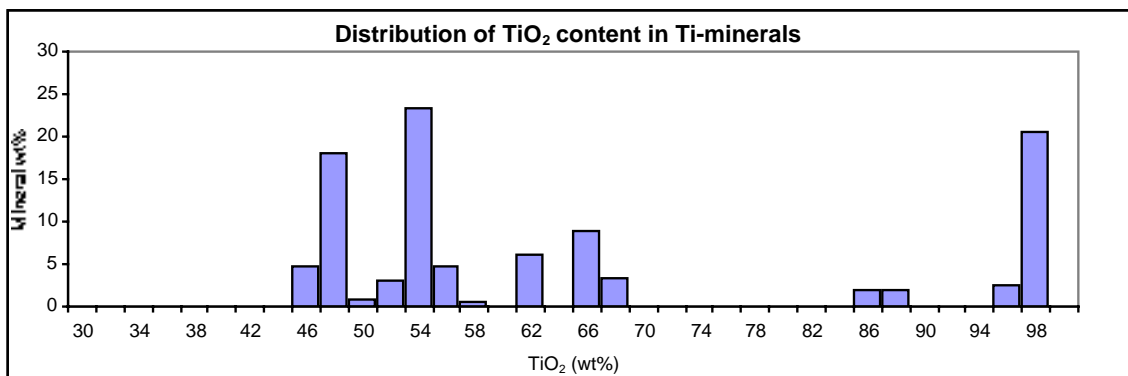
2000767 Average TiO<sub>2</sub> in ilmenite: 52.47



2000768 Average TiO<sub>2</sub> in ilmenite: 53.59

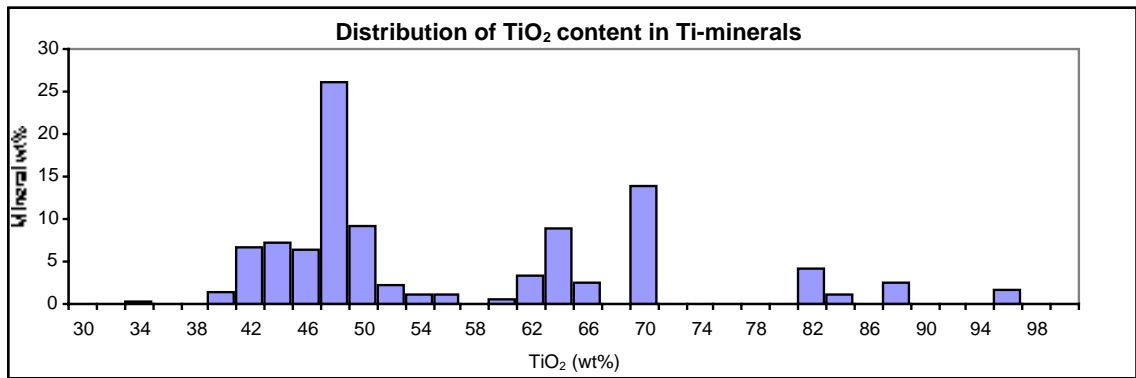


2000769 Average TiO<sub>2</sub> in ilmenite: 55.39

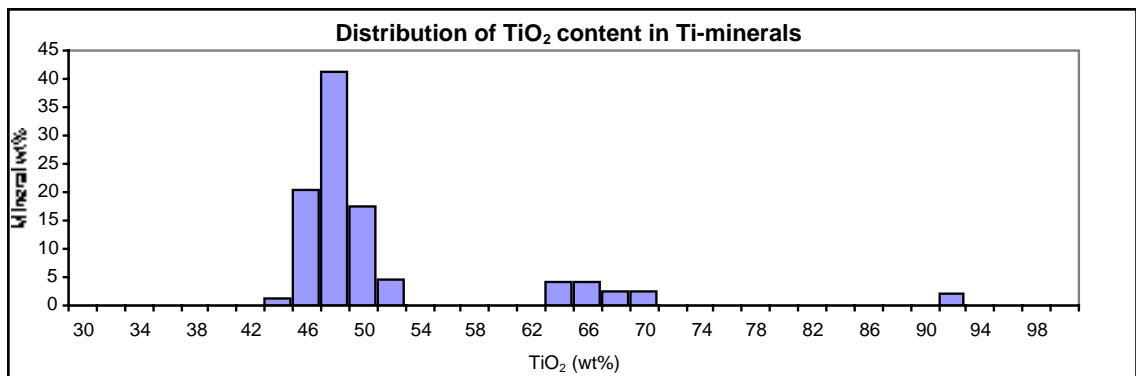


2000771 Average TiO<sub>2</sub> in ilmenite: 54.60

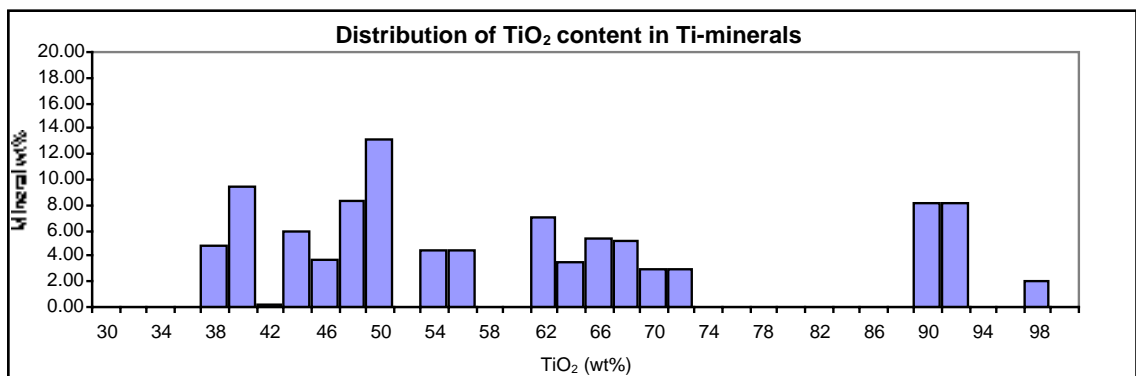




2000773 Average TiO<sub>2</sub> in ilmenite: 51.36



2000775 Average TiO<sub>2</sub> in ilmenite: 50.05



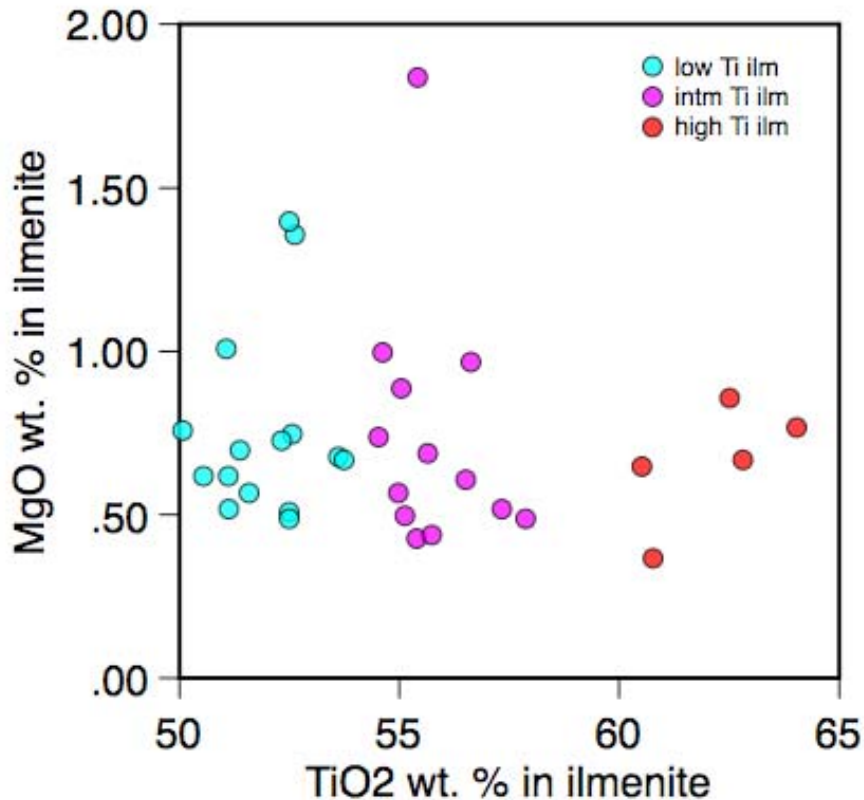
2000777 Average TiO<sub>2</sub> in ilmenite: 53.72

In Fig. 3 is presented a summary of the individual samples in terms of the distribution of TiO<sub>2</sub> in Ti minerals. The two samples 39 and 40 have low average TiO<sub>2</sub> in ilmenite, and the ilmenite found in these samples probably comes from the Mesozoic volcanic rocks exposed along the east coast of Madagascar and from the extensive belt of Precambrian orthogneisses, including charnockites, which forms the basement to the volcanic cover. A similar distribution of TiO<sub>2</sub> is seen for sample 42, from the Isandra river, which drains part of the same orthogneiss lithologies. The picture changes as the sample locations move south. Samples 41 to 50 (excluding the high-Ti sample 49) are similar in displaying a more complex distribution of TiO<sub>2</sub> in titanium minerals. Several of these samples have elevated TiO<sub>2</sub> in ilmenite (up to 56.6 wt. %), and they all show a bimodal distribution of TiO<sub>2</sub> in ilmenite, with a distinct group of low-Ti ilmenite, with TiO<sub>2</sub> peaking around 50 or 5<sub>2</sub> wt. % and a less well defined group of ilmenite with elevated TiO<sub>2</sub> from 55 to >70 wt. % TiO<sub>2</sub>. It is interesting to note that the low-TiO<sub>2</sub> population ilmenite in the samples apparently changes so that

samples 39, 40, 42, 44, 46, 48, and 50 have a low TiO<sub>2</sub> ilmenite population with TiO<sub>2</sub> of around 50 wt. %, while the samples 41, 43, 45, and 47 have a low TiO<sub>2</sub> ilmenite population with TiO<sub>2</sub> of around 52 wt. %. This suggests that there may be at least three major sources for ilmenite in these sediment samples, one with around 50 and one with around 52 wt. % TiO<sub>2</sub>, and one of altered ilmenite with TiO<sub>2</sub>>58 wt. %. The origin of the altered ilmenite could be either of the low-Ti ilmenite populations, but the three types of ilmenite must reside in different reservoirs, since the samples show clear bimodal distributions. This is in contrast to intermediate-Ti samples from Kerala beaches in India, where there exists a gradual, skewed normal distribution in TiO<sub>2</sub> of ilmenite in the samples (see Bernstein, 2003, Fig. 3 therein, samples 2000248 and 250).

The five high-Ti samples (49, 51, 52, 53, and 55) contain very few ilmenite grains with low TiO<sub>2</sub>. In fact, most of the samples contain no unaltered ilmenite grains (TiO<sub>2</sub> < 52.6 wt.%, which is the stoichiometric value), and sample 55, which have the highest TiO<sub>2</sub> of 64 wt. % for average ilmenite, is remarkable in having >90 % of the ilmenite grains with between 60 and 70 wt. % TiO<sub>2</sub>. This is a much narrower compositional range for ilmenite than found in high Ti samples from Kerala beaches. Sample 55 is found some 7km inland from the coast in what appears to be palaeobeach sediments, perhaps raised beaches. The two samples 54 and 56 found at the coast, about 10km from sample 55, contain a low-Ti ilmenite component, with TiO<sub>2</sub> at around 50-52 wt. %, and thus have lower average TiO<sub>2</sub> of 57-58 wt. %. These two samples, however, contain relatively few ilmenite grains in the range 64-68 wt. % TiO<sub>2</sub>, which is the range at which sample 55 contains most ilmenite grains. The most likely explanation for this must be that ilmenite in sample 55 has been altered to high purity in situ. Alternatively, but less likely, is ilmenite in sample 55 derived from a different source than ilmenite in the nearby sample 54 and 56.

From about 30km west of samples 55-56, the lithologies change into sedimentary basins of various ages. Distribution of TiO<sub>2</sub> in ilmenite changes accordingly, and TiO<sub>2</sub> in average ilmenite is low in the samples 57-64. There is little difference in the distribution of TiO<sub>2</sub> in Ti minerals and, more specifically, in ilmenite between these samples, although samples 57, 58, and 61 all come from inland sedimentary basins, and samples 59, 63, and 64 are from beaches. From 30km west of Cap St. Marie, the distribution of TiO<sub>2</sub> in Ti minerals changes again, heralded by the intermediate-Ti samples 65 and 66, which mostly contain altered ilmenite in the range 52-60 wt. % TiO<sub>2</sub>. These two samples come from an area of flat sandy plains within the sedimentary basin. Continuing towards the northwest, the TiO<sub>2</sub> distribution of Ti minerals becomes complex. All samples contain a relatively high fraction of altered ilmenite (TiO<sub>2</sub> > 52.6 wt. %), and most also contain a significant proportion of rutile, which is nearly absent in samples from the samples east of sample 61. Sample 68 is particularly interesting, because it contains two distinct groups of ilmenite. One group of altered ilmenite with unusually low TiO<sub>2</sub> of 44-52 wt. %, and one group with TiO<sub>2</sub> mainly between 58 and 70 wt. % TiO<sub>2</sub>. There is a clear compositional gap between the two groups. It is not possible to determine whether the ilmenite is altered in situ, and the low TiO<sub>2</sub> ilmenite simply is resistant to the alteration processes, or, whether the high TiO<sub>2</sub> ilmenite is derived from a separate source, which already has undergone alteration. Due to the present arid climate in southeastern Madagascar, the latter explanation is favoured.

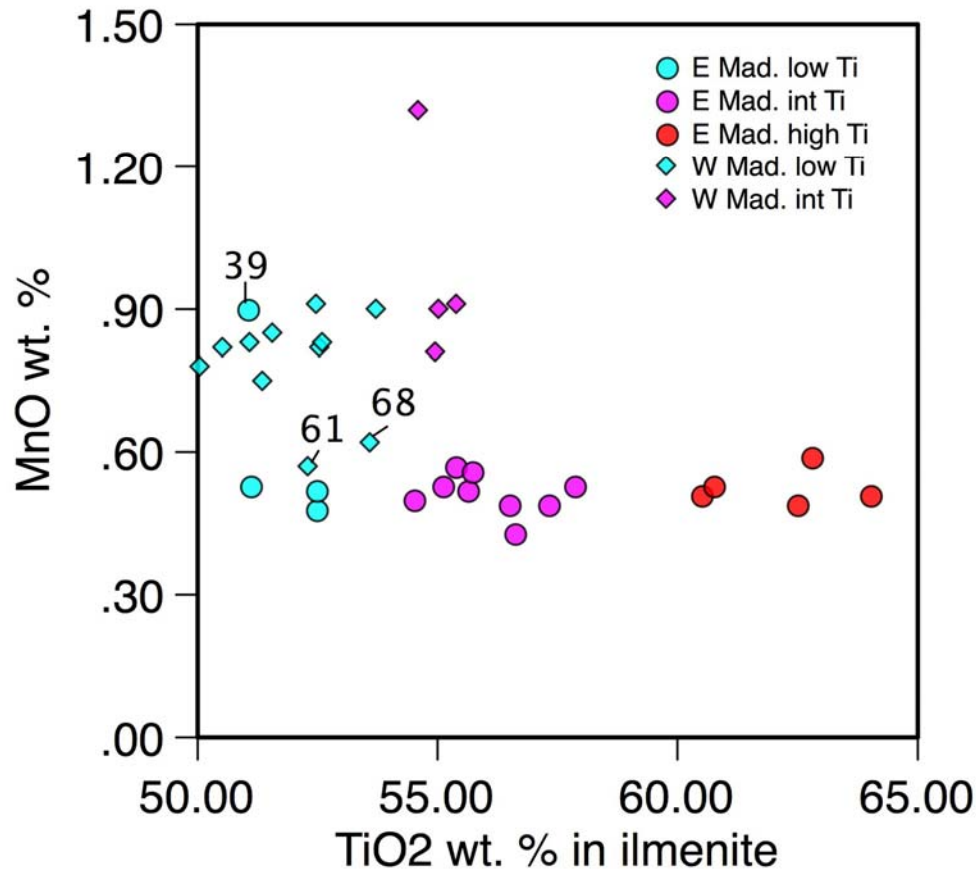


**Figure 4.** *MgO versus TiO<sub>2</sub> in average ilmenite from southern Madagascar.*

## 5.2 Ilmenite chemistry

In contrast to the study from India (Bernstein, 2003), there appears to be no correlation between average MgO in ilmenite and the average TiO<sub>2</sub> (Fig. 4). There is a large variation in MgO in ilmenite for the high-Ti samples (0.4 to 0.9 wt. %) and similarly large variations for MgO in the low- and intermediate-Ti samples. Manganese, on the other hand, yields considerable more information. In Fig. 5, it appears that samples from the eastern part of southern Madagascar (samples 39-56), which all come from areas adjacent to the A1-A2 schists of the khondalite belt (Fig. 1), have low MnO (0.4-0.6 wt. %), except sample 39. The anomalously high MnO of sample 39 is best explained by the fact that ilmenite at this sampling site must be derived mainly from the Cretaceous volcanics. Samples from western Madagascar (samples 57 to 78) have significantly higher MnO, namely 0.75 to 0.9 wt. %. Exceptions to this is one sample (71) with 1.3 wt. % MnO, and two samples (61 and 68) which have MnO of around 0.6 wt. %. It is here of particular interest to note that one of

these two samples with low MnO is sample 68, which contains a high-Ti ilmenite population.

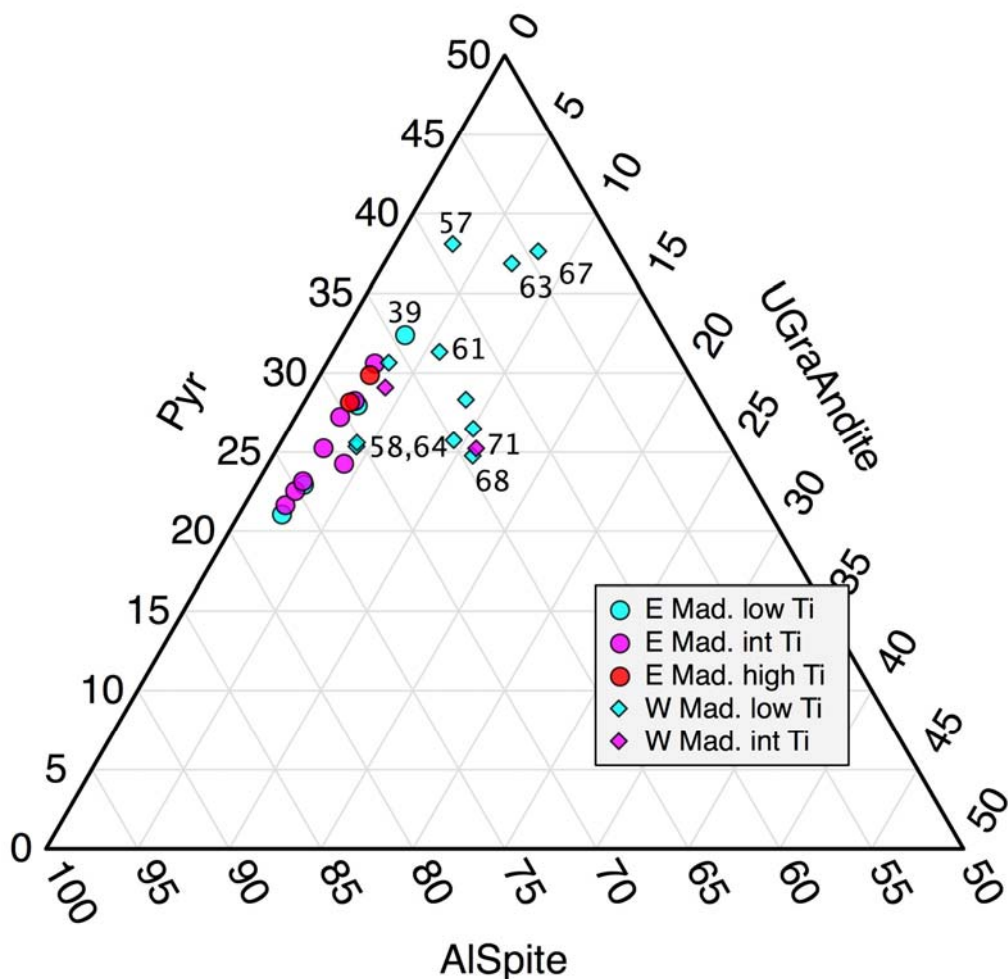


**Figure 5.** MnO versus TiO<sub>2</sub> in average ilmenite from Madagascar. Circles represent samples from eastern Madagascar (east of sample 57), while diamonds represent samples from western Madagascar (west of sample 57). The colours refer to TiO<sub>2</sub> contents in average ilmenite (see legend).

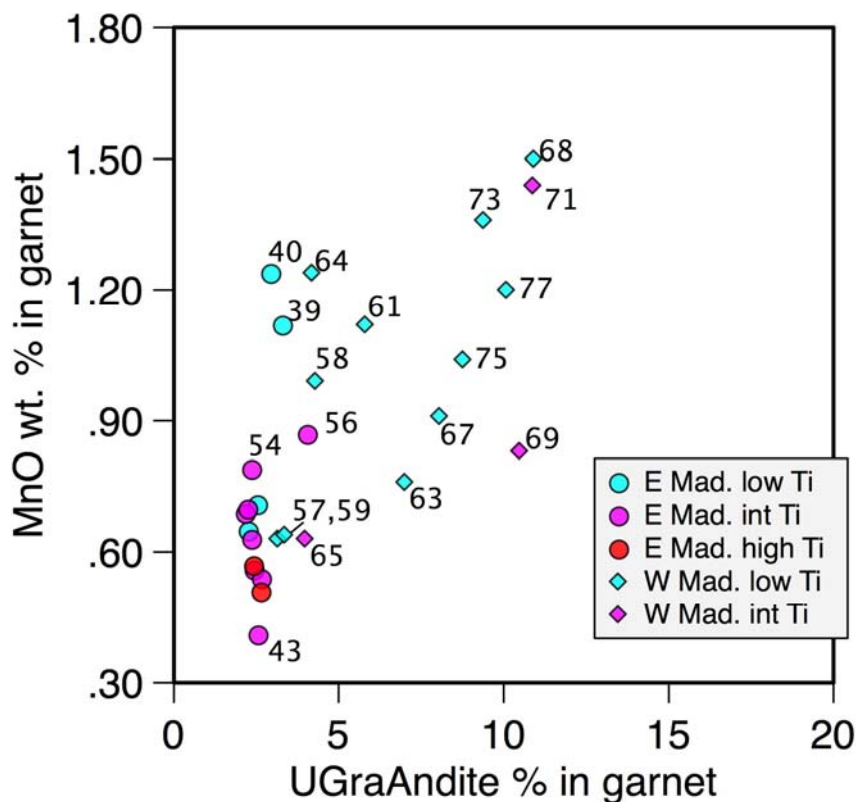
### 5.3 Garnet chemistry

Average garnet compositions from the 33 samples are presented in Fig. 6 in terms of the three ideal end-member components. The samples from eastern Madagascar form a coherent group with uniformly low grossular components of 2.1 - 4.0%, and pyrope contents of between 21 and 32.5%. Sample 39 lies the high pyrope end of the group. Most samples from western Madagascar have elevated contents of the grossular component, with values that generally lie between 6 and 12 %. There are some exceptions, namely samples 57, 58, 59, 64, and 65, which all have between 4 and 5 % grossular component in their average

garnet. Of these, the three samples 57, 58, and 59 represent the area at the eastern edge of the sedimentary basin that occupies the western Madagascar (Fig. 2). It is thus likely that the sediment represented by these samples receive a substantial amount of garnets from the schists which also feed the sediments sampled in eastern Madagascar. Manganese content in the garnets from eastern Madagascar is mainly low, in particular for the samples that also contain high-Ti ilmenite (Fig. 7). Due to the low contents of garnets in high-Ti samples, only two samples from this group are represented in this figure, but they plot at the lower end of the MnO group, with 0.45-0.55 wt. % MnO in average garnet. Garnets from western Madagascar either have higher MnO or higher grossular components and therefore are distinctly different from garnets from the eastern Madagascar samples. Three samples have both low MnO and low grossular garnets, and these are, again, samples 57, 59, and 65.



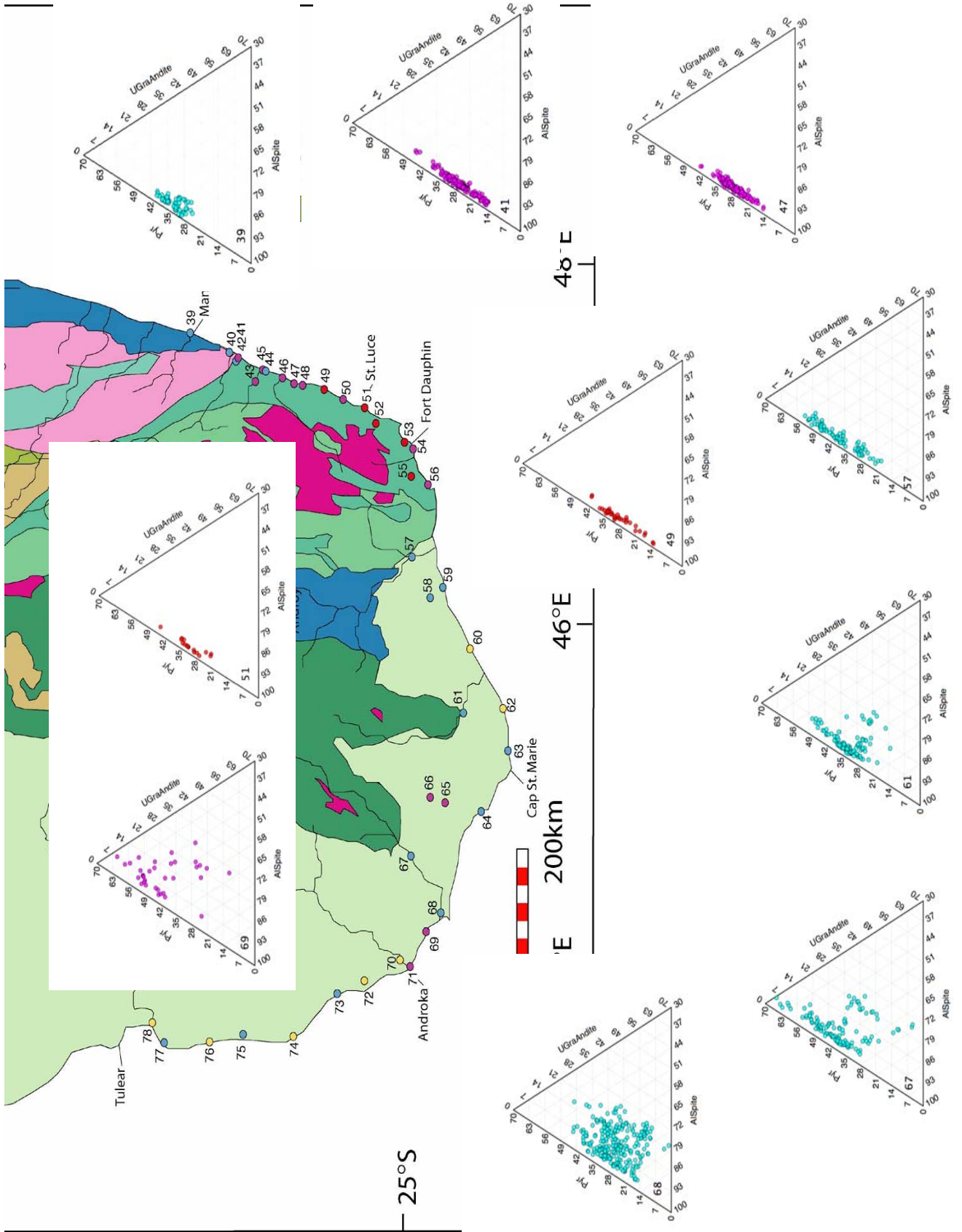
**Figure 6.** Composition of average garnet in terms of the ideal end member components Pyrope-Almandine+Spessartine-Ca-garnets (Uvarovite+Grossular+Andradite).



**Figure 7.** *MnO versus Ca-garnet component in average garnets from Madagascar.*

### 5.4 Compositional distribution of garnets

Individual garnet analyses for selected samples are presented in Fig. 8. For the northernmost sample 39, garnets show a relatively restricted compositional range, with pyrope values between ca. 25 and 40%. Samples from the coast south of sample 39 (samples 40 to 56) all show larger ranges in pyrope components, regardless of the Ti content of the average ilmenites. In Fig. 8 are presented four samples from this coast stretch, including the two intermediate-Ti samples 41, and 47, and the two high-Ti samples 49, and 51. For all four samples the range in pyrope is between ca. 15 and 37% (the range in sample 51 is smaller, perhaps because of the smaller population of garnet grains). For curiosity, it is worth noting that all these 4 samples contain a small population of garnets with about 40-44 % pyrope - and separated from the main body of garnet data. The high average pyrope garnet in samples 39, likely suggests derivation from the Archaean-Neoproterozoic gneiss terrain that extends to the north and west underneath the Cretaceous volcanic cover (Fig. 2).



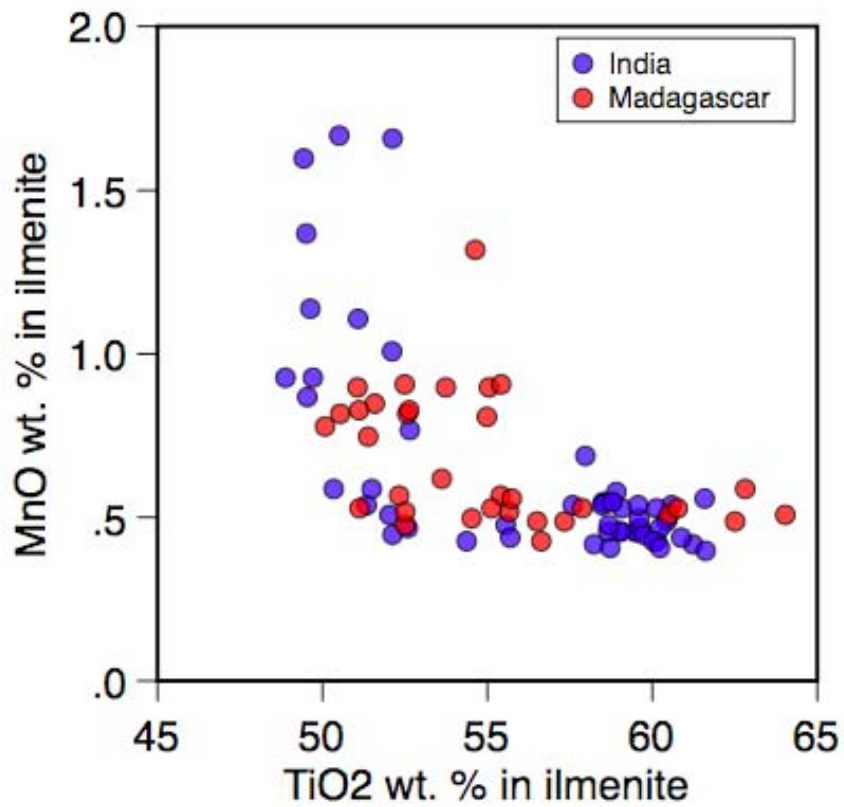
**Figure 8.** Individual garnet compositions for a series of selected samples from Madagascar. Sample numbers are given in lower left corner of the garnet triangles. Colour of symbols refer to high-Ti samples (red), intermediate-Ti samples (purple), and low-Ti samples (blue).

The sampled areas west of sample 56, referred to as western Madagascar, yield garnets with distinctly different compositions, compared to the samples 39-56. The first samples west of 56 is 57, and in this sample there is still quite a few garnets with the low grossular components, but a new group enters the scene, with pyrope contents to 53%. Sample 59 is similar to 57, showing that some garnets are still derived from the A1-A2 schists. In the samples 61 and 64, a low grossular garnet population still occurs, but from west of 64, all analysed garnets contain more than 4% grossular component, and most are considerably higher, with values up to 28%. In general the variations in the ideal garnet end-member components are large, within the garnets from individual samples. This is not surprising since the sediment samples come from a sedimentary basin which have been active over a long time span of nearly half a billion years, and thus is likely to represent material from a variety of source rocks.

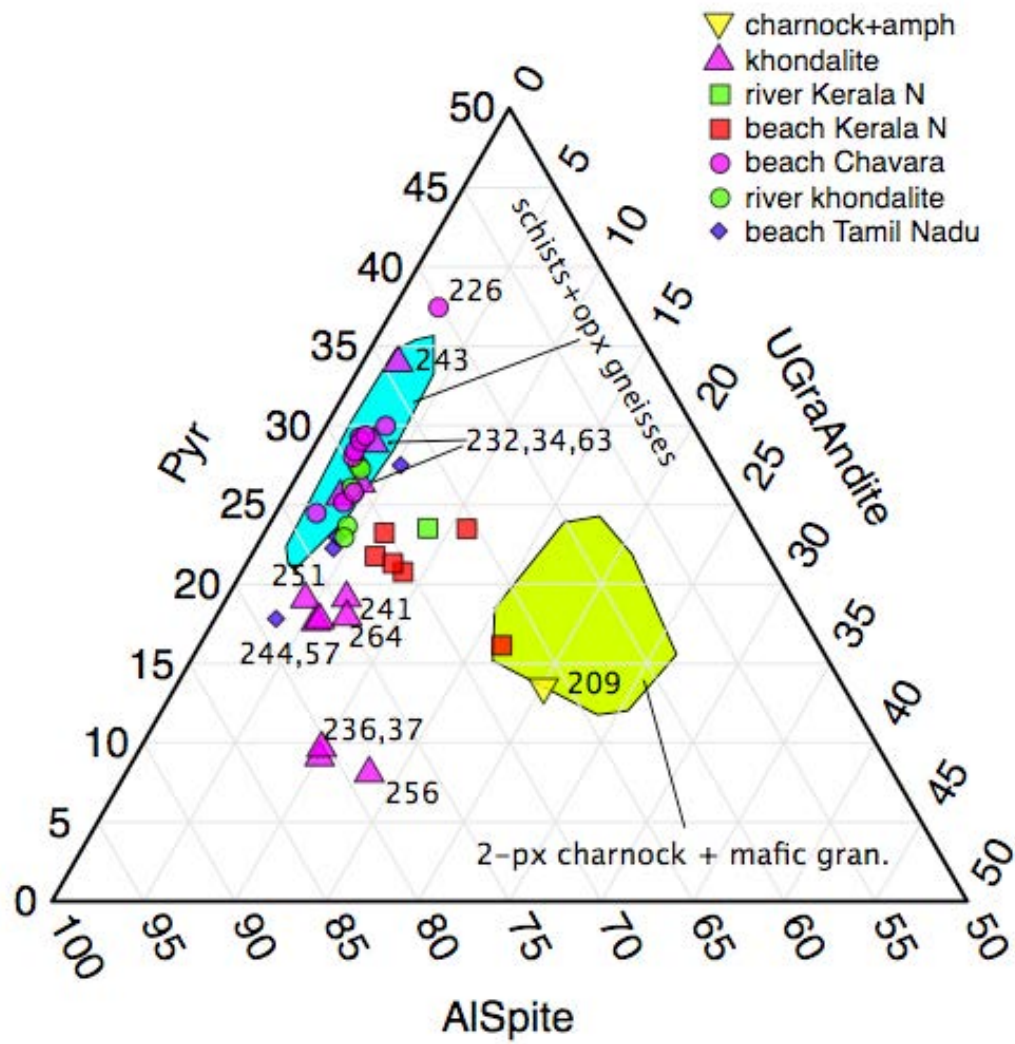
## **5.5 Comparison with India sediment samples**

Comparing the ilmenite compositions from Madagascar and India sediment samples (Fig. 9) shows that there is a very good agreement in terms of MnO-TiO<sub>2</sub> systematics between the two countries. All India and all Madagascar samples with average ilmenite higher than 56 wt. % TiO<sub>2</sub> have MnO between 0.4 and 0.6 wt. %. Sediments from north Kerala, i. e. outside the beaches that receive material from the khondalite belt, have MnO in average ilmenite from 0.8 to 1.6 wt. %. A similar behavior is found in samples from western Madagascar, as discussed above. Comparing the garnet compositions from India (Figs. 10 and 11) and Madagascar shows that there is extremely good agreement between high-Ti sample from the two countries. This not only confirms the suggestion of granulite facies metasediments from the khondalite belts to be the source rocks for the high grade ilmenite, but it also attests to a common origin for the belts of metasediment in India and Madagascar.

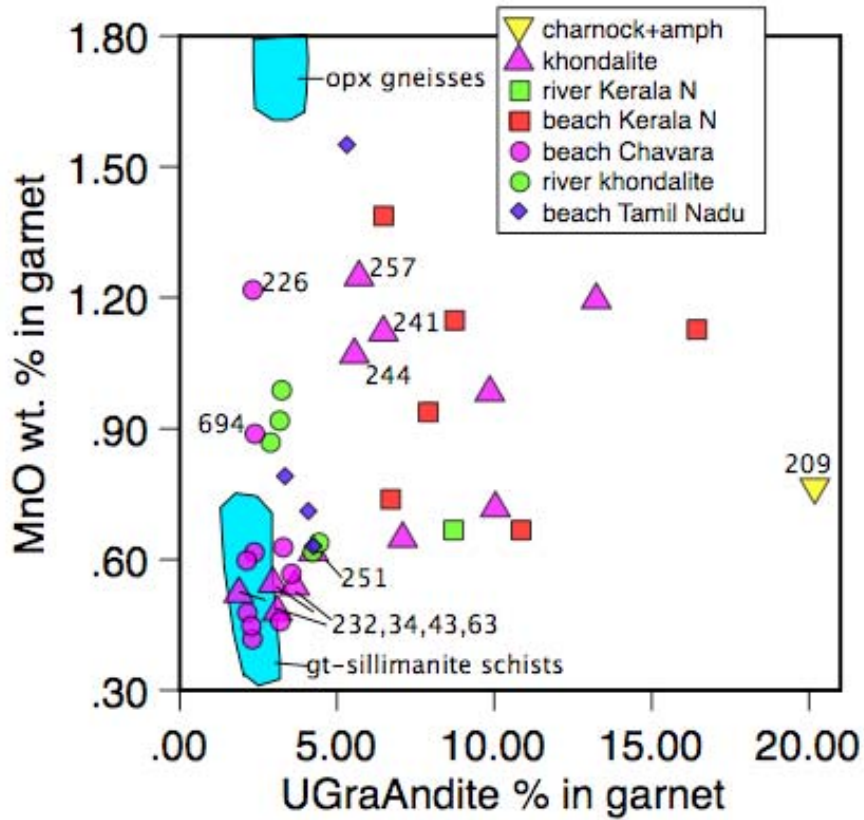




**Figure 9.** Composition of average ilmenite in sediments from India (data from Stendal et al., 2003; and Bernstein, 2003), compared to ilmenite in sediments from Madagascar (this study). Note the uniform, and low MnO of ilmenite in all samples with average ilmenite having TiO<sub>2</sub>>56 wt. %.



**Figure 10.** Composition of average garnets from sediments and rocks from southern India. Compare garnet compositions from Indian high-Ti samples (purple circles) with garnets from high-Ti samples from Madagascar (Fig. 6). (Data and figure from Bernstein, 2004).



**Figure 11.** Composition of average garnets from sediments and rock from southern India. Compare garnet compositions from Indian high-Ti samples (purple circles) with garnets from high-Ti samples from Madagascar (Fig. 7). (Data and figure from Bernstein, 2004).

## 6. Future developments

The recognition of high-Ti ilmenite in several sediment samples from southern Madagascar indicates a high potential for economic deposits of ilmenite. The stretch of coast with high-grade ilmenite is in length and grade comparable to that of the Chavara deposits in Kerala State, southern India. It is recommended that the outline of the potential deposits from around Fort Dauphin and some 100km north is refined by further sampling of sediments. Since the potential source rocks outcrop close to the coast, a set of rock samples should also be collected, which together with sediment samples should provide further insight into the ilmenite alteration processes.

Likewise, the area around and east of Androka (Fig. 2) in western Madagascar should also be sampled to test the potential of the samples which have indicated some intermediate-Ti ilmenite deposits.

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## 8. Appendix 1

# Madagascar field diary.

## Sediment sampling programme 17/5-14/6-2004

Geologist Rasmus Christensen

### General remarks.

This field diary is written as a rough itinerary of the day to day travels and activities. Samples are listed and described on the date they were taken. Place names in the sample descriptions refer to the nearest settlement on the 1:100.000 map for quick identification of the sample sites. All GPS positions are taken in WGS 84 on the UTM net.

17/5-2004

Arrived in Antananarivo international airport. Met with guide (prearranged through personal contacts)

18/5-2004

Reconnaissance day. Visits to a variety of ministries in order to inquire about the necessary permits.

19/5-2004

Acquired a prospecting license for the southern part of Madagascar at "Bureau central du cadastre minier"

20/5-2004

Route planning, buying supplies and booking transport.

21/5-2004

Taxibrousse from Antananarivo to Fianarantsoa. Papers stamped at the regional mining office in Fianarantsoa.

22/5-2004

Transport day. Train from Fianarantsoa to Manakara

23/5-2004

Transport day. Taxibrousse from Manakara to Farafangana and then from Farafangana to Vangaindrano.

24/5-2004

Taxibrousse from Vangaindrano to Manambondro.

Sample: Mad04-01 GEUS 2000739

Pos.

S 23 48.708

E 047 32.793

Manambondro river app. 7 km inland. Medium-coarse sand. According to local information part of a flood deposit from a cyclone in 1970.

25/5-2004

Got a ride with lobster buyers from Manambondro to Sandraviny.

**Sample: Mad04-02 GEUS 2000740**

Pos.

S 24 02.481

E 047 28.564

Mahavelona. 500 m inland from the coast. Partly stabilized coastal dune

26/5-2004

Walking (with porter) and navigating rivers in piroques (dugout canoes) from Sandraviny to Mororoy.

**Sample: Mad04-03 GEUS 2000741**

Pos.

S 24 04.249

E 047 27.060

Fenoarivo. Sample from the inland side of stabilized coastal dunefield app. 1 km wide and up to app. 70 m asl.

**Sample: Mad04-04 GEUS 2000742**

Pos.

S 24 05.124

E 047 26.795

Fenoarivo. Sample from area between the stabilized dunefield and the sea. Looks like raised beach ridges.

**Sample: Mad04-05 GEUS 2000743**

Pos.

S 24 09.733

E 047 20.628

Andriambe river app. 10 km inland at Mororoy village. Fine grained river sediment.

27/5-2004

Went down Andriambe river in piroque. Got a ride with lobster buyers to Manantenina. The geology in this region is characterized by a steep foreshore, app. 50 m of beach and coast parallel stabilized coastal dunefields up to 1 km wide. Behind the dunefields a rolling grassy plain with numerous gullies stretches back to the mountain range. The plain is made up from deeply eroded bedrock with a thin cover of red soil. Small deposits of Aeolian sand can be found as far back as 5-6 km from the coast, but usually quite small and with a maximum thickness of 1-2 m.

**Sample: Mado4-06 GEUS 2000744**

Pos.

S 24 11.349

E 047 23.952

App. 1 km south of the mouth of Andriambe river. Scattered outcrops of bedrock in the surf. 5 m erosional coastal cliff. Material appears to be from old beach ridges. Garnet makes up app. 50% of the heavies.

**Sample: Mad04-07 GEUS 2000745**

Small sample of heavies sorted and concentrated on the beach. 200 m north of Mad04-06. 28/5-2004

Rented ex-army truck and drove from Manantenina to Vatominindry with stops on the way to collect samples. The road runs between 2-7 km from the coast.

**Sample: Mad04-08 GEUS 2000746**

Pos.

S 24 18.761

E 047 20.241

Ampasamosay. Low stabilized coastal dunes. Dunefield app. 1,2 km wide with a short transition inland where eroded bedrock dominates.

**Sample: Mad04-09 GEUS 2000747**

Pos.

S 24 23.745

E 047 18.666

Esama. Stabilized coastal dunefield. Very swampy area with coast-parallel small rivers running behind the dunefield and deeply eroded bedrock crops out in numerous places.

**Sample: Mad04-10 GEUS 2000748**

Pos.

S 24 26.007

E 047 18.197

Ankaramany. Large stabilized coastal dune.

**Sample: Mad04-11 GEUS 2000749**

Pos.

S 24 32.113

E 047 16.442

Manambato. Inlandside of coastal dunefield app. 700 m from the sea.

29/5-2004

By truck from Watominindry to Fort Dauphin.

**Sample: Mad04-12 GEUS 2000750**

Pos.

S 24 40.855

E 047 12.770

Watominindry. Possibly old beach ridge as sediment is coarser than the samples from the dunes, but difficult to establish on the basis of the morphology. Width of deposit app. 300 m.



**Sample: Mad04-13 GEUS 2000751**

Pos.

S 24 46.751

E 047 11.770

Saint Luce. Active dunes (100 m wide, 10 m asl.) composed mainly of shell fragments.

Sample collected in flat area behind the active dunes, old beach?

30/5-2004

Day of rest in Fort Dauphin.

31/5-2004

Rented car in order to collect samples in the Fort Dauphin area.

**Sample: Mad04-14 GEUS 2000752**

Pos.

S 24 50.661

E 047 06.279

Belavenoka. Sediment from raised beach ridge 4-5 km inland from recent coast.

**Sample: Mad04-15 GEUS 2000753**

Pos.

S 25 00.210

E 046 58.982

3 km north of Fort Dauphin. Very steep active dune (angle of repose). App. 40 m asl.

1/6-2004

Rented 4wd with driver for the trip Fort Dauphin to Toliare. This day Fort Dauphin to Ambosary.

**Sample: Mad04-16 GEUS 2000754**

Pos.

S 25 04.003

E 046 56.238

Ambinambe. The inland side of steep partially active coastal dune. Heavies visible in wind ripples. Behind the dune lots of bedrock outcrops.

**Sample: Mad04-17 GEUS 2000755**

Pos.

S 25 03.004

E 046 48.394

Manambaro. Gently sloping sand plain with small-scale dunes. Dug sample holes in quite a few places but not a lot of visible heavies.

**Sample: Mad04-18 GEUS 2000756**

Pos.

S 25 08.387

E 046 46.536

Italy. App. 300 m wide active dunefield between the sea and a large bedrock outcrop. Some shell fragments in the sand.

2/6-2004

Ambosary to Tsiombe

**Sample: Mad04-19 GEUS 2000757**

Pos.

S 25 02.833

E 046 22.748

Mandrare river at Ambosary. Sample from large pointbarre in the partially dry riverbed. Well developed cross stratification with drapings of heavies. Fine-coarse sand.

**Sample: Mad04-20 GEUS 2000758**

Pos.

S 25 13.522

E 046 11.998

Maroaloka. Coastal dunefield app. 250 m wide.

**Sample: Mad04-21 GEUS 2000759**

Pos.

S 25 08.420

E 046 06.183

4 km north of Ambovombe. Inland sedimentary basin. Difficult area to sample as a cementlike crust has formed a few cm below the surface due to the arid nature of the region. Flat to gently rolling plain.

**Sample: Mad04-22 GEUS 2000760**

Pos.

S 25 22.593

E 045 50.590

Katoala Tannanbao. Very large active coastal dune complex. 700-800 m wide and 40-50 m asl. Some shell fragments in the sand.

3/6-2004

Tsiombe to Beloha. Very arid region. Very little relief.

**Sample: Mad04-23 GEUS 2000761**

Pos.

S 25 19.197

E 045 28.976

Manambovo river at Tsiombe. Dry river bed. This river only carries water a few months a year. Coarsegrained sand dominates.

**Sample: Mad04-24 GEUS 2000762**

Pos.

S 25 34.163

E 045 31.669

Faux Cap. 300 m wide active coastal dunefield. Finegrained sand with some shell fragments.

**Sample: Mad04-25 GEUS 2000763**

Pos.

S 25 34.753

E 045 17.801

Ankaratravitra. Sand plain gently rising inland. Large active dune field along the coast. Fine-coarse grained sand dominates the plain.

**Sample: Mad04-26 GEUS 2000764**

Pos.

S 25 25.192

E 044 56.338

Lavanono. Coastal dunes. Lots of heavies on the beach and in the dunesand.

**Sample: Mad04-27 GEUS 2000765**

Pos.

S 25 13.866

E 045 01.208

1 km north of Barabay. Flat sandy plain. Some outcropping bedock.

**Sample: Mad04-28 GEUS 2000766**

Pos.

S 25 09.930

E 045 04.311

1 km northeast of Beloha. Flat sand plain. Fine grained sand.

4/6-2004

Beloha to Androka.

**Sample: Mad04-29 GEUS 2000767**

Pos.

S 25 03.168

E 044 40.870

Menarandra river at Ampotaka. Sample taken from the dry river bed. Lots of heavies. Dominating grainsize is fine-coarse grained sand with some clay drapes and few walnut size stones. River bed is 500-600 m wide.

**Sample: Mad04-30 GEUS 2000768**

Pos.

S 25 12.528

E 044 27.008

Lahitsitely. Looks like old dunefield 5-6 km inland. Gently undulating landscape with very old vegetation.

**Sample: Mad04-31 GEUS 2000769**

Pos.

S 25 08.746

E 044 18.279

Ampalaza. Partly stabilized coastal dunefield. Heavies visible in wind ripples. Apparently lots of heavies in this region ( from sites Mad04-31 to Mad04-35).

**Sample: Mad04-32 GEUS 2000770**

Pos.

S 24 58.066

E 044 08.449

Ilinta river at Saodona. Dry river bed. Medium-coarse sand dominates but also few clay drapes visible.

5/6-2004

Androka to Anakao

**Sample: Mad04-33 GEUS 2000771**

Pos.

S 25 01.843

E 044 04.402

Androka. Very large active coastal dune complex. Dunes stretching app. 1 km inland.

**Sample: Mad04-34 GEUS 2000772**

Pos.

S 24 46.802

E 043 58.298

Nisoa. Gently undulating sand plain. Fine-medium sand with visible garnet + other heavies.

**Sample: Mad04-35 GEUS 2000773**

Pos.

S 24 38.460

E 043 56.575

Lavavolo. Coastal dune field. Lots of garnet in this region.

**Sample: Mad04-36 GEUS 2000774**

Pos.

S 24 21.627

E 043 40.852

Lanivato. Coastal dunes. Sand somewhat mixed with shell fragments.

**Sample: Mad04-37 GEUS 2000775**

Pos.

S 24 05.587

E 043 41.891

Efoetse. Sand plain behind the coastal dunes. Sand does not seem to be well sorted, but that is typical of the sand plain.

**Sample: Mad04-38 GEUS 2000776**

Pos.

S 23 54.198

E 043 40.602

Beloha. Low coastal dunes. Fine grained sand. Heavies visible in the wind ribbles.

**Sample: Mad04-39 GEUS 2000777**

Pos.

S 23 09.094

E 043 39.171

Anakao. Low coastal dunes. Fine-coarse sand (seems to be quite unsorted for coastal dunes) few shell fragments.

6/6-2004

Anakao to Toliare

**Sample: Mad04-40 GEUS 2000778**

Pos.

S 23 32.115

E 044 19.312

Onilahy river at Tongobory. River sediments. Medium-coarse sand.

7/6-2004

Day spent at various offices in Toliare. Mayors office and the regional office for the ministry of mining.

8/6-2004

Rest day

9/6-2004

Domestic flight back to Antananarivo and straight to the ministry to apply for an export license.

10/6-2004

Another day at the offices in the ministry.

11/6-2004

Got the last stamps for the export permit.

12/6-2004

Rest day

13/6-2004

Packing samples and equipment. Off to the airport and back to Denmark with the samples!!

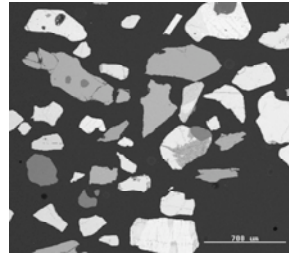
## 9. Appendix 2

CCSEM report sheets for 33 sediment samples 2000739-2000777.



Geological Survey of Denmark and Greenland  
 Øster Voldgade 10, DK-1350 Copenhagen K  
 Ph.: +45 38142000, Fax: +45 38142050

Sample Name:	2000739	No. of frames analysed:	64
Lab. Name:	739	No. of particles analysed:	652
Date:	08/07/04	Heavy minerals in raw sand (%):	15,5
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	400 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	51.0	44.6	0.9	0.1	0.3	0.4	1.0	0.1	0.2	98.6
Leucoxene	72.7	14.6	0.3	0.2	5.8	5.0	0.4	0.1	0.1	99.1
Rutile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ti magnetite	29.4	65.8	0.7	0.2	0.6	1.1	0.7	0.1	0.3	98.8
Magnetite	15.1	81.1	0.4	0.2	0.4	1.4	0.3	0.1	0.1	98.9
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.2	25.2	1.1	0.1	42.1	21.6	7.4	1.0	0.1	98.8
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.4	0.1	0.1	29.4	0.1	0.1	0.0	65.1	95.5
Silicate	0.8	5.9	0.2	0.1	72.9	4.8	5.9	6.1	0.1	96.7
Unclassified	4.7	15.2	1.6	0.5	3.6	32.2	0.9	4.2	4.6	67.5

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	49.1	1.3	0.0	33.0	16.2	0.3	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	51.7	73.3	0	29.8
Fe <sub>2</sub> O <sub>3</sub> wt%	45.2	14.8	0	66.7
MnO wt%	0.9	0.3	0	0.7
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.2	0	0.2
SiO <sub>2</sub> wt%	0.3	5.8	0	0.6
Al <sub>2</sub> O <sub>3</sub> wt%	0.4	5.1	0	1.1
MgO wt%	1.0	0.4	0	0.7
CaO wt%	0.1	0.1	0	0.1
ZrO <sub>2</sub> wt%	0.2	0.1	0	0.3
Total	100.0	100.0	0	100.0

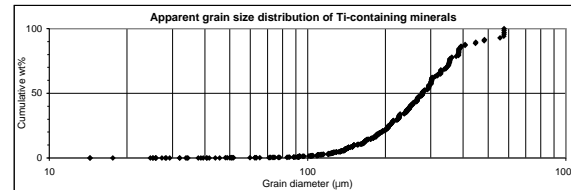
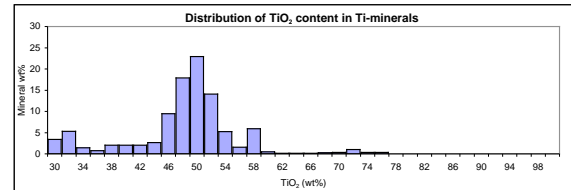
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	
	wt %	Raw sand wt %
Ilmenite	45.0	7.0
Leucoxene	1.2	0.2
Rutile	0.0	0.0
Ti magnetite	30.3	4.7
Magnetite	5.4	0.8
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	14.9	2.3
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.3	0.0
Silicate	2.7	0.4
Unclassified	0.3	0.0
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	43.4
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	43.4
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	739	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	08/07/04		

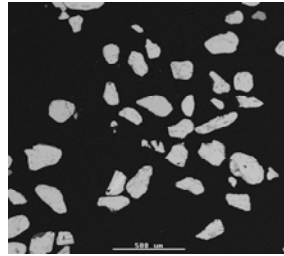


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	760	286	32881	344
Leucoxene	1.3	1.5	757	259	33980	9
Rutile	0.0	0.0	0	0	0	0
Ti magnetite	1.7	1.9	988	389	48427	148
Magnetite	1.7	1.9	1031	400	50744	23
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.7	2.2	1291	541	71251	59
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.5	1.7	722	265	25564	3
Silicate	1.6	1.8	704	264	32860	35
Unclassified	1.4	1.4	214	81	3703	31



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Sample Name:	2000740	No. of frames analysed:	31
Lab. Name:	740	No. of particles analysed:	714
Date:	19/08/04	Heavy minerals in raw sand (%):	99.20
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/50x		
Guard region:	200 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	51.1	45.1	0.5	0.1	0.4	0.8	0.5	0.1	0.2	98.6
Leucoxene	70.3	25.0	0.1	0.3	0.5	1.4	0.1	0.1	0.1	97.9
Rutile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ti magnetite	42.5	48.4	0.6	0.2	0.8	2.4	0.9	0.2	0.3	96.3
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.6	1.4	0.0	0.0	2.9	1.2	0.3	3.2	3.5	13.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.2	29.3	1.2	0.1	38.2	20.1	7.1	1.0	0.4	97.6
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.5	0.6	0.1	0.0	29.0	0.7	0.2	0.0	63.3	94.4
Silicate	1.3	12.0	0.5	0.1	51.3	3.6	25.8	0.5	0.7	95.7
Unclassified	3.2	26.2	1.1	0.7	1.9	36.0	2.8	0.7	2.6	75.2

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	92.8	0.2	0.0	5.9	0.8	0.3	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	51.8	71.8	0	44.2
Fe <sub>2</sub> O <sub>3</sub> wt%	45.7	25.5	0	50.3
MnO wt%	0.5	0.1	0	0.7
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.3	0	0.2
SiO <sub>2</sub> wt%	0.4	0.5	0	0.8
Al <sub>2</sub> O <sub>3</sub> wt%	0.8	1.5	0	2.5
MgO wt%	0.5	0.1	0	0.9
CaO wt%	0.1	0.1	0	0.2
ZrO <sub>2</sub> wt%	0.2	0.1	0	0.3
Total	100.0	100.0	0	100.0

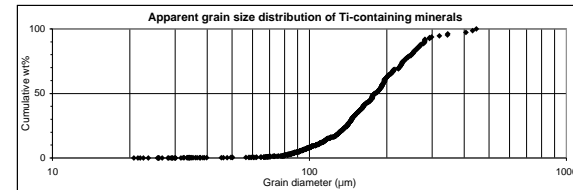
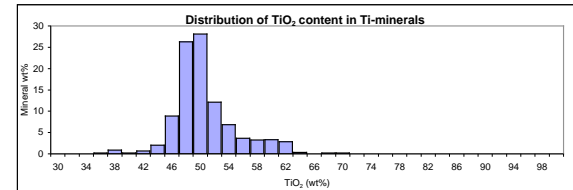
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	89.3	88.6
Leucoxene	0.2	0.2
Rutile	0.0	0.0
Ti magnetite	5.7	5.6
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.9	0.9
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	0.8	0.8
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.3	0.3
Silicate	0.1	0.1
Unclassified	2.8	2.7
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	51.4
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	51.4
Valuable heavy minerals in raw sand:	95.50

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Lab. Name:	740	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	19/08/04		



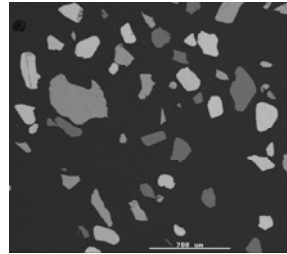
Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.7	582	219	17736	597
Leucoxene	2.0	2.0	383	152	5995	4
Rutile	0.0	0.0	0	0	0	0
Ti magnetite	1.7	1.8	493	190	13820	46
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.4	1.4	475	156	13794	7
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.3	1.6	386	141	9375	11
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.7	1.7	356	136	7003	5
Silicate	1.3	1.3	136	50	1542	7
Unclassified	1.5	1.6	465	174	14789	37





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Sample Name:	2000741	No. of frames analysed:	36
Lab. Name:	741	No. of particles analysed:	780
Date:	07/07/04	Heavy minerals in raw sand (%):	3.9
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	300 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	56.5	39.0	0.5	0.1	0.5	1.2	0.6	0.1	0.2	98.6
Leucoxene	76.6	10.8	0.1	0.1	4.6	5.2	0.3	0.2	0.3	98.2
Rutile	90.7	3.1	0.1	0.1	1.0	2.1	0.1	0.1	0.3	97.7
Ti magnetite	39.6	30.8	0.7	0.4	6.3	16.4	1.7	0.2	0.7	96.7
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	3.2	0.0	3.8	0.0	0.0	0.0	41.4	0.0	48.5
Monazite	0.0	1.0	0.0	0.0	0.7	1.6	0.0	1.0	8.3	12.6
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.3	27.8	0.6	0.1	41.6	21.7	5.6	0.7	0.2	98.5
Kya/Sill	0.1	0.7	0.2	0.1	43.1	53.4	0.0	0.1	0.2	97.9
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.2	0.4	0.2	0.1	28.9	0.5	0.1	0.1	64.4	94.8
Silicate	0.7	3.1	0.1	0.1	44.8	45.0	1.9	0.7	0.2	96.7
Unclassified	0.7	13.3	0.4	0.3	5.7	39.8	7.0	11.3	2.8	81.4

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	51.8	7.6	1.1	0.6	33.7	4.1	1.1	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	57.2	78.1	92.9	41.0
Fe <sub>2</sub> O <sub>3</sub> wt%	39.6	11.0	3.2	31.8
MnO wt%	0.5	0.1	0.1	0.7
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.1	0.4
SiO <sub>2</sub> wt%	0.5	4.7	1.1	6.5
Al <sub>2</sub> O <sub>3</sub> wt%	1.2	5.3	2.1	16.9
MgO wt%	0.6	0.3	0.1	1.7
CaO wt%	0.1	0.2	0.1	0.2
ZrO <sub>2</sub> wt%	0.2	0.3	0.3	0.7
Total	100.0	100.0	100.0	100.0

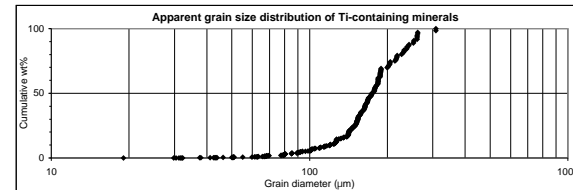
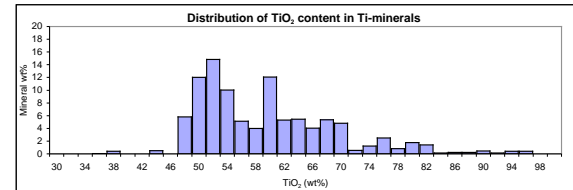
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	42.0	1.6
Leucoxene	6.2	0.2
Rutile	0.9	0.0
Ti magnetite	0.5	0.0
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	27.4	1.1
Kya/Sill	0.9	0.0
Staurolite	0.0	0.0
Zircon	3.3	0.1
Silicate	15.8	0.6
Unclassified	3.1	0.1
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	60.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	59.7
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	741	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	07/07/04		

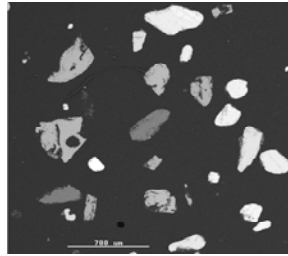


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.7	1.7	590	216	18622	232
Leucoxene	1.7	1.7	564	207	18714	34
Rutile	2.0	1.7	438	164	9296	9
Ti magnetite	1.3	1.3	229	79	4565	10
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	1.5	0.9	43	18	162	1
Monazite	1.3	1.3	147	42	1328	1
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.7	1.9	531	210	15307	207
Kya/Sill	1.5	1.8	510	195	12882	10
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.3	1.4	600	190	23465	14
Silicate	1.7	1.9	522	203	14947	185
Unclassified	1.7	1.7	367	144	8545	62



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Sample Name:	2000742	No. of frames analysed:	43
Lab. Name:	742	No. of particles analysed:	741
Date:	20/08/04	Heavy minerals in raw sand (%):	8.70
Submitter:	tefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	400 µm		
Sieve:	100 µm <sup>2</sup>		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	52.5	41.4	0.5	0.1	1.7	1.5	0.5	0.1	0.2	98.3
Leucoxene	75.5	12.1	0.3	0.3	4.0	3.8	0.1	0.2	0.5	96.9
Rutile	89.0	2.3	0.2	0.2	3.5	2.8	0.1	0.1	0.2	98.2
Ti magnetite	39.9	46.9	0.7	0.2	4.4	4.1	0.5	0.1	0.2	97.0
Magnetite	2.4	71.2	0.8	0.2	10.2	7.8	0.5	0.9	1.0	95.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	1.7	0.0	0.0	7.0	3.5	0.4	2.9	5.5	20.9
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.4	31.8	0.6	0.1	38.3	19.9	4.9	0.9	0.4	97.4
Kya/Sill	0.2	1.3	0.1	0.2	42.6	53.6	0.0	0.1	0.1	98.1
Staurolite	1.0	8.6	0.0	0.2	39.9	44.2	0.1	0.0	0.6	94.7
Zircon	0.1	1.3	0.1	0.2	29.5	0.5	0.1	0.1	63.7	95.6
Silicate	1.4	13.7	0.2	0.2	45.2	28.9	2.2	0.9	0.5	93.2
Unclassified	2.3	21.0	0.7	0.5	12.7	39.2	5.2	0.7	2.0	84.4

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	54.8	1.9	0.6	8.8	31.5	1.0	1.4	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	53.4	78.0	90.6	41.1
Fe <sub>2</sub> O <sub>3</sub> wt%	42.1	12.5	2.4	48.3
MnO wt%	0.5	0.3	0.2	0.7
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.3	0.2	0.2
SiO <sub>2</sub> wt%	1.7	4.2	3.5	4.5
Al <sub>2</sub> O <sub>3</sub> wt%	1.5	3.9	2.8	4.2
MgO wt%	0.5	0.1	0.1	0.6
CaO wt%	0.1	0.2	0.1	0.1
ZrO <sub>2</sub> wt%	0.2	0.5	0.2	0.2
Total	100.0	100.0	100.0	100.0

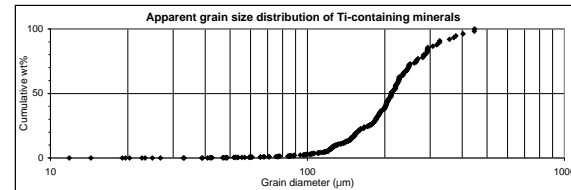
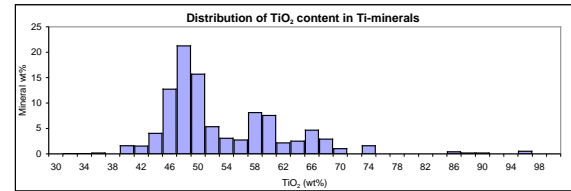
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	50.1	4.4
Leucoxene	1.8	0.2
Rutile	0.5	0.0
Ti magnetite	8.1	0.7
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.4	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	28.8	2.5
Kya/Sill	1.2	0.1
Staurolite	0.0	0.0
Zircon	0.9	0.1
Silicate	3.7	0.3
Unclassified	4.5	0.4
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	52.8
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	52.4
Valuable heavy minerals in raw sand:	7.95

Geological Survey of Denmark and Greenland  
 Øster Voldgade 10, DK-1350 Copenhagen K  
 Ph.: +45 38142000, Fax: +45 38142050



Lab. Name:	742	Analyzed by:	JK
Submitter:	tefan Bernstein	Acc. Voltage:	17kV
Date:	20/08/04		

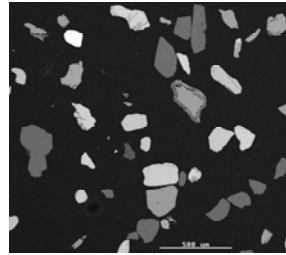


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.6	676	248	26015	263
Leucoxene	1.5	1.5	624	225	30346	8
Rutile	1.4	1.6	373	134	10430	6
Ti magnetite	1.5	1.7	591	224	19602	53
Magnetite	1.1	1.0	69	26	386	7
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.7	1.6	450	158	10749	5
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.6	2.1	682	286	24892	178
Kya/Sill	1.7	1.9	625	250	19660	12
Staurolite	1.3	1.2	105	33	731	1
Zircon	1.7	1.6	660	237	23441	5
Silicate	1.5	1.5	294	115	7230	118
Unclassified	1.5	1.7	413	163	14421	71



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Sample Name:	2000743	No. of frames analysed	41
Lab. Name:	743	No. of particles analysed:	862
Date:	05/07/04	Heavy minerals in raw sand (%):	7.1
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/50x		
Guard region:	300 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	56.6	37.1	0.4	0.1	1.1	1.9	1.0	0.1	0.1	98.4
Leucoxene	77.2	14.0	0.3	0.1	1.5	3.9	0.3	0.1	0.7	98.1
Rutile	93.5	1.1	0.2	0.0	0.7	1.6	0.1	0.1	0.3	97.6
Ti magnetite	36.2	38.8	0.5	0.1	7.8	11.6	1.1	0.1	0.9	97.1
Magnetite	0.5	57.0	0.1	0.2	7.7	29.1	0.4	0.3	0.8	96.2
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	21.7	17.9	0.0	0.0	1.3	2.6	0.6	2.0	5.9	52.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.4	23.7	0.4	0.1	44.0	22.9	6.2	0.7	0.1	98.6
Kya/Sill	0.2	1.0	0.0	0.2	42.6	53.3	0.0	0.0	0.5	98.0
Staurolite	0.8	9.8	0.7	0.0	32.5	47.8	0.2	0.8	0.4	93.0
Zircon	0.1	0.1	0.2	0.0	29.5	0.0	0.1	0.0	64.7	94.8
Silicate	0.3	1.8	0.1	0.1	55.7	38.8	0.4	0.1	0.2	97.5
Unclassified	1.1	18.6	0.4	0.6	4.4	56.7	6.4	0.7	1.4	90.3

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		Staurolite
wt %	71.0	13.1	4.5	1.3	8.2	1.7	0.1	0.1	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	57.5	78.7	95.8	37.3
Fe <sub>2</sub> O <sub>3</sub> wt%	37.7	14.3	1.1	40.0
MnO wt%	0.4	0.3	0.2	0.5
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.0	0.1
SiO <sub>2</sub> wt%	1.1	1.6	0.7	8.1
Al <sub>2</sub> O <sub>3</sub> wt%	1.9	3.9	1.6	12.0
MgO wt%	1.0	0.3	0.1	1.2
CaO wt%	0.1	0.1	0.1	0.1
ZrO <sub>2</sub> wt%	0.2	0.7	0.3	0.9
Total	100.0	100.0	100.0	100.0

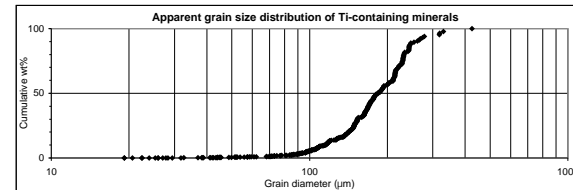
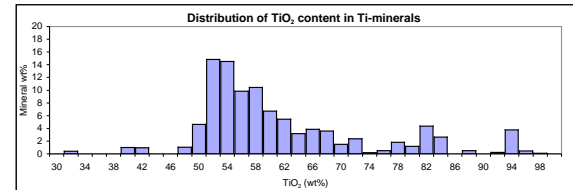
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	48.5	3.4
Leucoxene	9.0	0.6
Rutile	3.1	0.2
Ti magnetite	0.9	0.1
Magnetite	0.3	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.2	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	5.6	0.4
Kya/Sill	0.1	0.0
Staurolite	0.0	0.0
Zircon	1.1	0.1
Silicate	20.7	1.5
Unclassified	10.5	0.7
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	62.2
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	60.4
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	743	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	05/07/04		

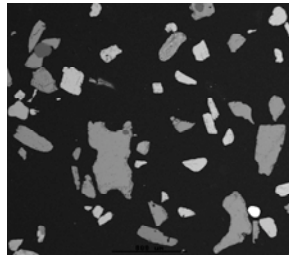


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	576	215	17793	288
Leucoxene	1.5	1.8	682	257	24296	39
Rutile	1.7	1.6	537	198	17346	17
Ti magnetite	1.4	2.2	647	277	18018	5
Magnetite	1.4	1.6	305	108	4781	6
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.5	2.6	876	376	23465	1
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.7	2.0	484	192	11091	60
Kya/Sill	1.5	1.6	261	98	4380	3
Staurolite	1.5	1.6	163	59	1369	4
Zircon	1.6	1.7	485	178	11619	10
Silicate	1.6	1.7	454	173	11929	311
Unclassified	1.5	1.7	481	184	15613	118



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Sample Name:	2000744	No. of frames analysed:	45
Lab. Name:	744	No. of particles analysed:	878
Date:	31/08/04	Heavy minerals in raw sand (%):	23.70
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/30x		
Guard region:	500 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	52.5	43.7	0.5	0.1	0.5	0.5	0.5	0.1	0.2	98.6
Leucoxene	74.8	13.6	0.2	0.1	5.0	3.6	0.5	0.1	0.3	98.2
Rutile	95.1	1.1	0.1	0.0	1.0	0.9	0.1	0.1	0.0	98.4
Ti magnetite	38.4	53.3	0.8	0.1	1.7	2.0	0.7	0.1	0.4	97.5
Magnetite	0.8	82.8	0.4	0.1	1.5	10.9	0.5	0.2	0.5	97.8
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.2	33.9	0.7	0.1	37.5	19.3	5.6	1.3	0.1	98.7
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.2	0.6	0.1	0.2	29.3	0.1	0.1	0.1	65.2	95.8
Silicate	1.1	17.0	0.3	0.1	58.2	8.5	6.7	2.8	0.1	94.8
Unclassified	2.6	26.3	1.0	1.0	7.8	30.5	4.3	6.0	2.6	82.2

Category	Valuable heavy minerals							Total
	wt %	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	
	46.0	6.6	2.0	3.9	40.7	0.8	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	53.2	76.2	96.6	39.4
Fe <sub>2</sub> O <sub>3</sub> wt%	44.4	13.8	1.1	54.7
MnO wt%	0.5	0.2	0.1	0.9
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.0	0.1
SiO <sub>2</sub> wt%	0.5	5.1	1.1	1.8
Al <sub>2</sub> O <sub>3</sub> wt%	0.5	3.6	0.9	2.1
MgO wt%	0.5	0.5	0.1	0.7
CaO wt%	0.1	0.2	0.1	0.1
ZrO <sub>2</sub> wt%	0.2	0.3	0.0	0.4
Total	100.0	100.0	100.0	100.0

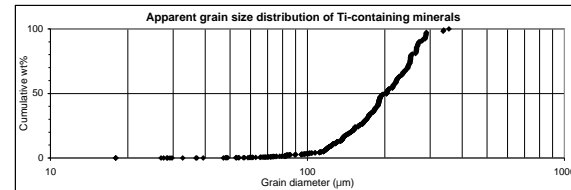
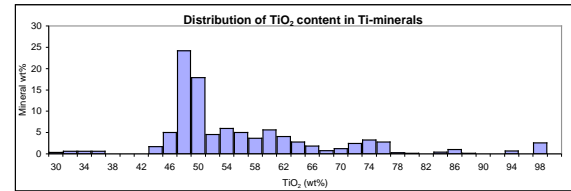
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	40.4	9.6
Leucoxene	5.8	1.4
Rutile	1.8	0.4
Ti magnetite	3.4	0.8
Magnetite	0.2	0.1
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	35.7	8.5
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.7	0.2
Silicate	3.7	0.9
Unclassified	8.2	1.9
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	56.4
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	54.9
Valuable heavy minerals in raw sand:	20.82

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Lab. Name:	744	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	31/08/04		

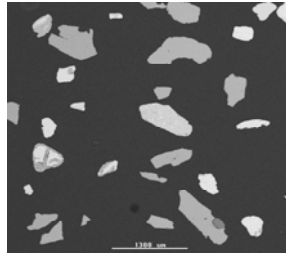


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.7	649	244	21823	383
Leucoxene	1.6	1.7	779	294	30582	39
Rutile	1.5	1.5	592	204	19665	17
Ti magnetite	1.4	1.7	653	239	22770	29
Magnetite	1.5	1.4	314	107	6827	6
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.7	2.1	871	350	35506	234
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.5	1.7	631	238	20486	7
Silicate	1.8	1.9	625	248	20399	64
Unclassified	1.7	1.9	753	296	28594	99



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Sample Name:	2000745	No. of frames analysed:	46
Lab. Name:	745	No. of particles analysed:	720
Date:	06/07/04	Heavy minerals in raw sand (%):	71.2
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	400 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	54.5	41.1	0.5	0.1	0.6	0.6	0.7	0.1	0.2	98.4
Leucoxene	72.9	18.7	0.3	0.0	3.1	2.4	0.5	0.1	0.2	98.3
Rutile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ti magnetite	39.3	42.5	0.6	0.0	9.1	1.5	1.0	1.8	0.6	96.3
Magnetite	0.3	95.8	0.0	0.4	1.0	0.8	0.6	0.2	0.1	99.2
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	36.2	0.8	0.0	0.0	30.8	2.4	0.2	27.7	0.0	98.1
Garnet	0.1	25.9	0.5	0.1	42.6	21.7	6.0	1.2	0.2	98.4
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.2	0.1	0.1	29.1	0.0	0.1	0.0	0.0	64.6
Silicate	0.7	13.6	0.3	0.1	53.0	12.4	12.3	4.9	0.2	97.6
Unclassified	2.1	19.0	0.2	0.3	4.6	46.6	6.9	5.4	1.8	87.0

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		Staurolite
wt %	32.9	1.7	0.0	0.8	63.7	0.9	0.0	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	55.4	74.1	0	40.8
Fe <sub>2</sub> O <sub>3</sub> wt%	41.7	19.1	0	44.1
MnO wt%	0.5	0.3	0	0.6
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0	0.0
SiO <sub>2</sub> wt%	0.6	3.2	0	9.4
Al <sub>2</sub> O <sub>3</sub> wt%	0.6	2.5	0	1.5
MgO wt%	0.8	0.5	0	1.1
CaO wt%	0.1	0.2	0	1.9
ZrO <sub>2</sub> wt%	0.2	0.2	0	0.6
Total	100.0	100.0	0	100.0

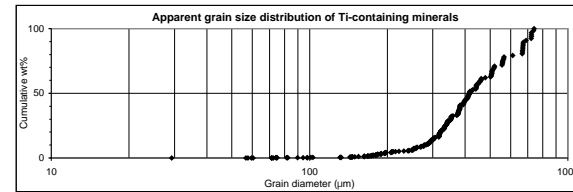
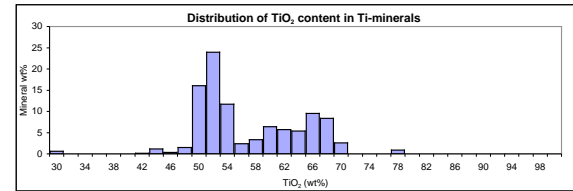
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	29.4	20.9
Leucoxene	1.5	1.1
Rutile	0.0	0.0
Ti magnetite	0.7	0.5
Magnetite	0.1	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.4	0.3
Garnet	56.8	40.5
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.8	0.6
Silicate	3.9	2.8
Unclassified	6.4	4.5
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	55.9
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	55.9
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	745	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	06/07/04		

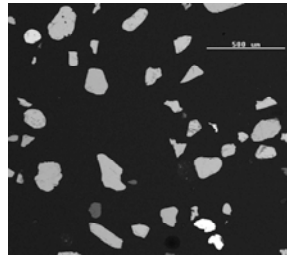


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	1316	485	98221	260
Leucoxene	1.5	1.7	2298	859	261495	5
Rutile	0.0	0.0	0	0	0	0
Ti magnetite	1.5	1.6	1146	427	81220	7
Magnetite	1.8	1.4	483	154	13464	3
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	2.1	2.1	2480	1015	228427	2
Garnet	1.8	2.0	1918	775	180971	307
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.4	1.6	1054	370	58320	12
Silicate	1.5	1.9	1668	662	141152	41
Unclassified	1.5	1.7	1427	548	128414	72



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Sample Name:	2000746	No. of frames analysed:	35
Lab. Name:	746	No. of particles analysed:	795
Date:	01/09/04	Heavy minerals in raw sand (%):	16.90
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/50x		
Guard region:	200 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	55.3	41.1	0.6	0.1	0.4	0.6	0.4	0.0	0.2	98.7
Leucoxene	75.6	18.8	0.2	0.1	1.4	1.5	0.1	0.1	0.4	98.2
Rutile	94.9	2.2	0.1	0.0	0.5	0.4	0.1	0.1	0.2	98.4
Ti magnetite	34.0	48.4	0.5	0.1	3.5	6.3	0.4	0.1	2.0	95.2
Magnetite	0.7	55.8	0.6	0.2	13.8	23.4	1.7	0.3	0.6	97.1
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	2.1	4.7	0.0	0.0	3.6	1.3	0.3	3.7	6.7	22.3
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kya/Sill	0.3	1.2	0.1	0.2	42.8	53.7	0.0	0.0	0.2	98.4
Staurolite	0.7	10.9	0.3	0.4	35.3	45.0	5.0	0.2	0.4	98.2
Zircon	0.3	0.8	0.2	0.1	29.1	0.1	0.1	0.1	64.4	95.1
Silicate	0.9	1.7	0.2	0.2	47.0	46.3	0.6	0.5	0.2	97.3
Unclassified	3.5	15.3	0.4	1.0	7.8	20.5	3.0	3.9	8.7	64.0

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	83.3	5.4	2.5	1.4	0.0	4.0	3.5	0.1	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	56.0	77.0	96.4	35.7
Fe <sub>2</sub> O <sub>3</sub> wt%	41.6	19.1	2.2	50.8
MnO wt%	0.6	0.2	0.1	0.5
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.0	0.1
SiO <sub>2</sub> wt%	0.4	1.4	0.5	3.6
Al <sub>2</sub> O <sub>3</sub> wt%	0.6	1.5	0.4	6.6
MgO wt%	0.4	0.1	0.1	0.4
CaO wt%	0.0	0.1	0.1	0.1
ZrO <sub>2</sub> wt%	0.2	0.4	0.2	2.1
Total	100.0	100.0	100.0	100.0

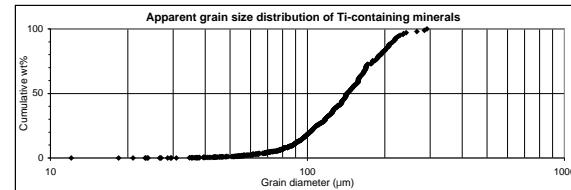
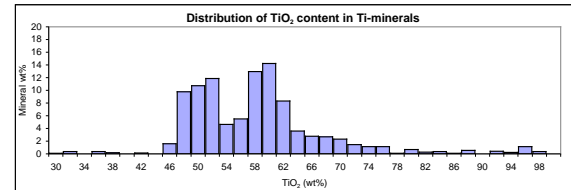
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	74.2	12.5
Leucoxene	4.8	0.8
Rutile	2.2	0.4
Ti magnetite	1.2	0.2
Magnetite	2.8	0.5
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	1.0	0.2
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	0.0	0.0
Kya/Sill	3.1	0.5
Staurolite	0.0	0.0
Zircon	3.5	0.6
Silicate	2.9	0.5
Unclassified	4.3	0.7
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	58.0
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	57.0
Valuable heavy minerals in raw sand:	15.06

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Lab. Name:	746	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	01/09/04		

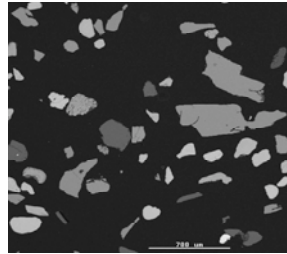


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	455	169	11201	527
Leucoxene	1.6	1.6	402	149	9300	41
Rutile	1.5	1.7	415	155	9273	17
Ti magnetite	1.6	1.8	407	162	8374	11
Magnetite	1.6	2.5	1524	658	96888	2
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	2.1	2.0	342	138	5706	12
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	0.0	0.0	0	0	0	0
Kya/Sill	1.7	1.8	474	186	12573	27
Staurolite	2.1	2.1	239	91	2269	2
Zircon	1.5	1.6	354	127	7539	36
Silicate	1.6	1.7	348	135	7621	51
Unclassified	1.6	1.8	383	150	8197	69



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Sample Name:	2000747	No. of frames analysed:	27
Lab. Name:	747	No. of particles analysed:	636
Date:	12/07/04	Heavy minerals in raw sand (%):	3.7
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	400 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	55.6	38.8	0.5	0.1	1.3	1.1	0.7	0.1	0.2	98.4
Leucoxene	75.4	13.4	0.2	0.2	4.4	3.9	0.3	0.2	0.2	98.1
Rutile	95.3	0.5	0.4	0.0	1.0	0.7	0.1	0.1	0.2	98.4
Ti magnetite	31.2	54.6	0.6	0.1	5.7	4.4	1.5	0.1	0.2	98.3
Magnetite	0.9	69.1	0.3	0.1	4.7	19.7	0.5	0.3	0.8	96.5
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	2.0	0.0	0.0	7.9	0.5	0.0	2.4	7.8	20.7
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.2	27.9	0.6	0.1	41.2	21.2	6.1	0.8	0.2	98.3
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.3	0.5	0.3	0.2	28.9	0.4	0.2	0.2	63.2	94.2
Silicate	0.2	4.7	0.2	0.2	47.2	41.0	1.8	1.0	0.2	96.4
Unclassified	0.4	19.9	0.2	0.6	6.1	48.6	4.4	3.1	2.7	86.0

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	41.5	3.9	0.5	2.2	50.9	1.0	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	56.5	76.9	96.9	31.7
Fe <sub>2</sub> O <sub>3</sub> wt%	39.4	13.6	0.5	55.6
MnO wt%	0.5	0.2	0.4	0.6
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.2	0.0	0.1
SiO <sub>2</sub> wt%	1.3	4.5	1.0	5.8
Al <sub>2</sub> O <sub>3</sub> wt%	1.1	4.0	0.7	4.5
MgO wt%	0.7	0.3	0.1	1.5
CaO wt%	0.1	0.2	0.1	0.1
ZrO <sub>2</sub> wt%	0.2	0.2	0.2	0.2
Total	100.0	100.0	100.0	100.0

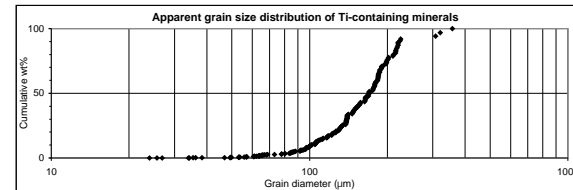
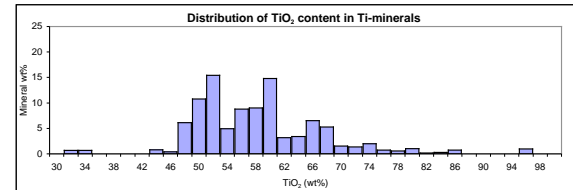
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	34.2	1.3
Leucoxene	3.2	0.1
Rutile	0.4	0.0
Ti magnetite	1.8	0.1
Magnetite	0.4	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.2	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	41.9	1.5
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.8	0.0
Silicate	12.6	0.5
Unclassified	4.5	0.2
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	57.4
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	57.0
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	747	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	12/07/04		

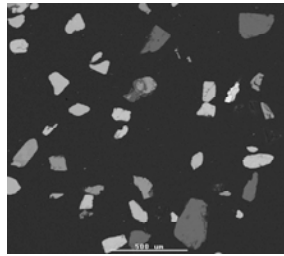


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.6	516	187	15418	176
Leucoxene	1.5	1.5	470	161	13528	19
Rutile	1.7	1.8	517	197	13402	2
Ti magnetite	1.9	2.2	709	283	19588	7
Magnetite	1.3	1.4	307	105	5873	5
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.3	1.8	557	216	13457	1
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.9	1.9	533	215	16126	232
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.7	1.5	315	110	5511	11
Silicate	1.9	2.0	539	217	14040	121
Unclassified	1.7	1.8	427	166	9588	62



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Sample Name:	2000748	No. of frames analysed:	32
Lab. Name:	748	No. of particles analysed:	670
Date:	06/09/04	Heavy minerals in raw sand (%):	17.60
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/50x		
Guard region:	250 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	55.1	40.7	0.5	0.1	0.7	0.9	0.5	0.1	0.1	98.6
Leucoxene	76.4	12.9	0.1	0.1	4.1	4.3	0.1	0.1	0.1	98.3
Rutile	91.7	2.6	0.1	0.1	1.5	1.5	0.1	0.1	0.2	97.9
Ti magnetite	39.8	47.2	0.5	0.1	3.0	3.5	1.0	0.2	0.2	95.5
Magnetite	0.4	57.3	0.4	0.4	18.3	16.2	2.5	0.8	0.3	96.5
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.8	0.0	0.0	3.2	0.8	0.3	2.8	7.8	15.7
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.2	33.5	0.7	0.1	37.5	19.5	5.4	0.8	0.7	98.4
Kya/Sill	0.2	1.1	0.1	0.2	42.7	53.6	0.0	0.0	0.3	98.2
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.2	0.9	0.1	0.1	29.2	0.3	0.1	0.1	64.7	95.7
Silicate	0.7	6.9	0.2	0.1	47.1	39.7	2.0	0.8	0.2	97.8
Unclassified	1.0	32.5	0.2	0.4	4.4	45.3	4.5	0.4	1.7	90.5

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	65.6	4.1	2.4	2.3	16.5	3.8	5.3	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	55.8	77.7	93.7	41.7
Fe <sub>2</sub> O <sub>3</sub> wt%	41.2	13.1	2.6	49.5
MnO wt%	0.5	0.1	0.1	0.5
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.1	0.1
SiO <sub>2</sub> wt%	0.7	4.2	1.5	3.2
Al <sub>2</sub> O <sub>3</sub> wt%	0.9	4.3	1.5	3.6
MgO wt%	0.5	0.1	0.1	1.0
CaO wt%	0.1	0.1	0.1	0.2
ZrO <sub>2</sub> wt%	0.1	0.1	0.3	0.2
Total	100.0	100.0	100.0	100.0

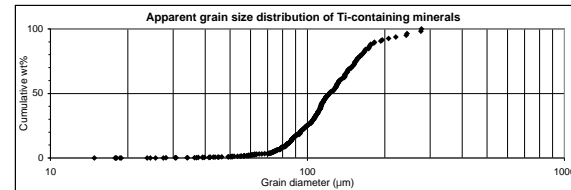
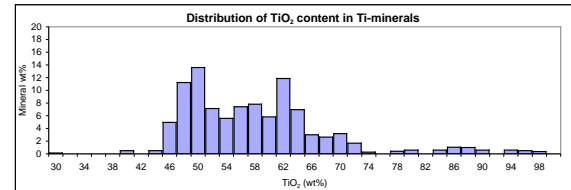
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	58.1	10.2
Leucoxene	3.7	0.6
Rutile	2.1	0.4
Ti magnetite	2.1	0.4
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.6	0.1
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	14.6	2.6
Kya/Sill	4.7	0.8
Staurolite	0.0	0.0
Zircon	3.3	0.6
Silicate	6.3	1.1
Unclassified	4.6	0.8
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	57.8
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	56.6
Valuable heavy minerals in raw sand:	15.57

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Lab. Name:	748	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	06/09/04		



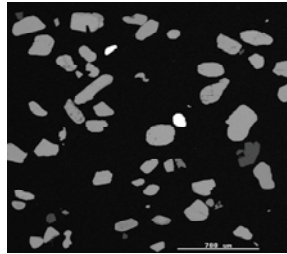
Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	416	155	9182	324
Leucoxene	1.6	2.3	578	238	12520	15
Rutile	2.0	1.7	421	157	8907	11
Ti magnetite	1.4	1.9	404	162	7646	13
Magnetite	1.3	1.2	67	22	303	3
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.7	1.6	349	122	6718	4
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.7	2.0	378	153	6669	126
Kya/Sill	1.5	1.8	496	192	13808	24
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.6	1.7	388	143	8248	20
Silicate	1.7	2.0	401	162	8051	68
Unclassified	1.6	1.8	354	139	6359	62





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Sample Name:	2000749	No. of frames analysed:	30
Lab. Name:	749	No. of particles analysed:	724
Date:	09/07/04	Heavy minerals in raw sand (%):	11.7
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	250 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	60.5	35.1	0.5	0.1	0.6	0.6	0.6	0.1	0.2	98.3
Leucoxene	75.7	20.4	0.3	0.1	0.5	0.9	0.2	0.2	0.2	98.5
Rutile	90.6	5.0	0.1	0.1	1.3	0.8	0.1	0.2	0.2	98.3
Ti magnetite	37.8	23.2	0.5	0.1	32.3	3.2	0.9	0.2	0.1	98.4
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.1	27.8	0.5	0.1	41.3	20.9	6.4	0.8	0.3	98.3
Kya/Sill	0.3	0.7	0.1	0.1	43.1	53.1	0.0	0.0	0.0	97.4
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.2	0.2	0.1	0.1	29.2	0.1	0.1	0.1	64.4	94.4
Silicate	0.4	0.7	0.1	0.1	78.9	14.4	0.2	0.1	0.2	95.2
Unclassified	1.2	19.0	0.2	0.4	5.8	45.6	4.4	0.7	1.9	79.4

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	77.4	8.6	1.6	1.1	4.3	6.7	0.3	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	61.5	76.9	92.1	38.4
Fe <sub>2</sub> O <sub>3</sub> wt%	35.7	20.7	5.1	23.6
MnO wt%	0.5	0.3	0.1	0.5
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.1	0.1
SiO <sub>2</sub> wt%	0.6	0.5	1.3	32.9
Al <sub>2</sub> O <sub>3</sub> wt%	0.6	0.9	0.9	3.3
MgO wt%	0.7	0.2	0.1	0.9
CaO wt%	0.1	0.2	0.2	0.2
ZrO <sub>2</sub> wt%	0.2	0.2	0.2	0.1
Total	100.0	100.0	100.0	100.0

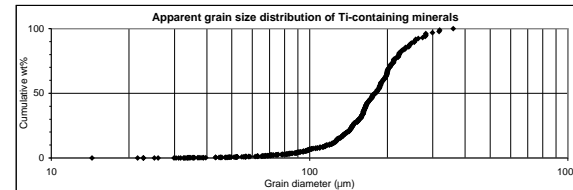
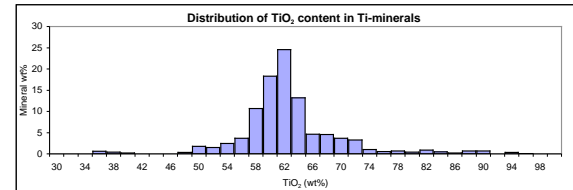
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	70.4	8.2
Leucoxene	7.8	0.9
Rutile	1.5	0.2
Ti magnetite	1.0	0.1
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	3.9	0.5
Kya/Sill	0.3	0.0
Staurolite	0.0	0.0
Zircon	6.1	0.7
Silicate	6.8	0.8
Unclassified	2.3	0.3
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	63.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	62.7
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	749	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	09/07/04		

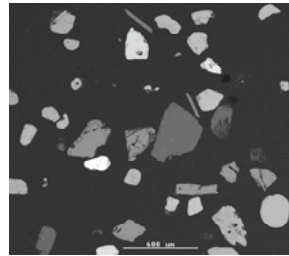


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.6	544	197	17221	430
Leucoxene	1.6	1.6	568	198	19561	42
Rutile	1.4	1.4	416	142	10815	13
Ti magnetite	1.6	3.3	962	429	23767	4
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.8	2.1	455	185	10322	45
Kya/Sill	1.8	1.8	490	181	10912	4
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.5	1.5	542	190	17167	36
Silicate	1.5	1.6	459	176	14095	86
Unclassified	1.5	1.7	330	128	6717	60



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Sample Name:	2000750	No. of frames analysed	54
Lab. Name:	750	No. of particles analysed:	778
Date:	07/09/04	Heavy minerals in raw sand (%)	6.30
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	400 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	55.7	39.3	0.6	0.1	1.1	1.1	0.4	0.1	0.1	98.5
Leucoxene	78.3	17.0	0.1	0.1	1.1	1.5	0.1	0.1	0.2	98.5
Rutile	93.4	1.9	0.2	0.1	2.7	0.6	0.1	0.0	0.0	99.0
Ti magnetite	42.1	43.1	0.6	0.1	5.0	5.9	0.5	0.1	0.3	97.8
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.6	0.0	0.0	2.0	0.7	0.2	2.0	6.6	12.1
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.2	33.1	0.7	0.1	37.9	19.5	5.7	1.1	0.2	98.5
Kya/Sill	0.2	1.2	0.1	0.1	42.7	53.6	0.0	0.2	0.1	98.3
Staurolite	0.6	9.2	0.0	0.0	39.9	46.0	0.2	0.3	0.1	96.4
Zircon	0.3	1.0	0.2	0.1	29.1	0.3	0.1	0.1	64.3	95.5
Silicate	1.5	9.3	0.2	0.1	42.8	36.6	3.5	2.0	0.3	96.2
Unclassified	0.4	23.3	0.4	0.4	4.9	51.2	9.0	0.3	1.7	91.7

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	57.4	2.4	0.5	0.9	35.1	3.1	0.7	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	56.5	79.5	94.4	43.0
Fe <sub>2</sub> O <sub>3</sub> wt%	39.8	17.3	1.9	44.1
MnO wt%	0.6	0.1	0.2	0.6
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.1	0.1
SiO <sub>2</sub> wt%	1.1	1.1	2.7	5.1
Al <sub>2</sub> O <sub>3</sub> wt%	1.2	1.5	0.6	6.0
MgO wt%	0.4	0.1	0.1	0.6
CaO wt%	0.1	0.1	0.0	0.1
ZrO <sub>2</sub> wt%	0.1	0.2	0.0	0.4
Total	100.0	100.0	100.0	100.0

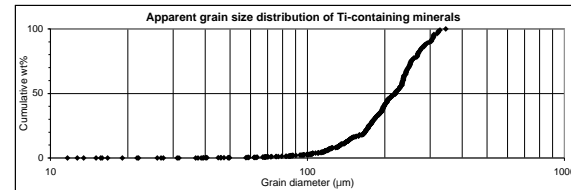
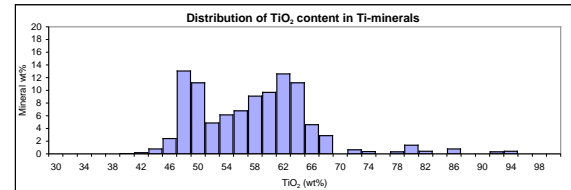
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	53.5	3.4
Leucoxene	2.2	0.1
Rutile	0.4	0.0
Ti magnetite	0.8	0.1
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.4	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	32.7	2.1
Kya/Sill	0.7	0.0
Staurolite	0.0	0.0
Zircon	2.9	0.2
Silicate	2.9	0.2
Unclassified	3.5	0.2
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	57.5
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	57.2
Valuable heavy minerals in raw sand:	5.87

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Lab. Name:	750	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage	17kV
Date:	07/09/04		

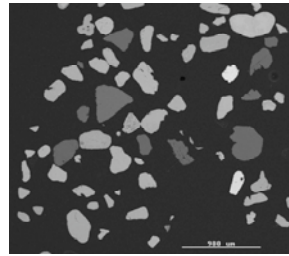


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.7	683	255	25436	364
Leucoxene	1.2	1.7	879	324	38012	10
Rutile	1.5	1.5	789	273	33347	2
Ti magnetite	1.4	1.4	298	107	6344	21
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.6	1.5	633	223	20879	3
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.7	2.3	800	338	31177	204
Kya/Sill	1.3	1.7	458	198	17716	9
Staurolite	1.1	1.0	64	23	322	3
Zircon	1.4	1.6	557	195	16684	29
Silicate	1.9	2.0	502	219	17439	49
Unclassified	1.5	1.8	426	170	12139	84



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Sample Name:	2000751	No. of frames analysed:	22
Lab. Name:	751	No. of particles analysed:	921
Date:	22/07/04	Heavy minerals in raw sand (%):	2.3
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/30x		
Guard region:	250 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	62.7	32.7	0.6	0.1	0.6	0.3	0.7	0.1	0.2	98.1
Leucoxene	73.3	22.3	0.4	0.1	0.6	0.4	0.4	0.3	0.2	98.1
Rutile	91.6	3.5	0.0	0.1	0.9	0.2	0.3	0.2	0.7	97.5
Ti magnetite	42.5	25.9	0.0	1.9	0.3	1.5	0.0	3.0	6.8	81.9
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.2	24.0	0.5	0.2	43.6	22.2	6.1	0.8	0.2	97.8
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.2	0.2	0.1	29.2	0.0	0.1	0.1	64.3	94.3
Silicate	0.4	0.5	0.1	0.1	60.1	35.5	0.1	0.3	0.2	97.1
Unclassified	3.8	8.7	0.6	0.2	1.5	55.1	13.9	3.7	2.8	90.1

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	74.6	21.0	0.3	0.0	1.5	2.6	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	64.0	74.7	94.0	51.9
Fe <sub>2</sub> O <sub>3</sub> wt%	33.3	22.7	3.6	31.6
MnO wt%	0.6	0.5	0.0	0.0
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.1	2.3
SiO <sub>2</sub> wt%	0.7	0.7	0.9	0.4
Al <sub>2</sub> O <sub>3</sub> wt%	0.3	0.4	0.2	1.9
MgO wt%	0.7	0.4	0.3	0.0
CaO wt%	0.1	0.3	0.2	3.7
ZrO <sub>2</sub> wt%	0.2	0.2	0.7	8.3
Total	100.0	100.0	100.0	100.0

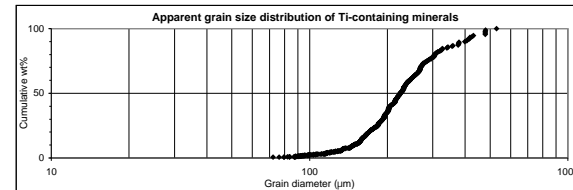
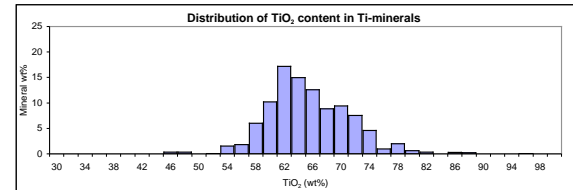
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	65.1	1.5
Leucoxene	18.3	0.4
Rutile	0.0	0.0
Ti magnetite	0.0	0.0
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	1.3	0.0
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	2.3	0.1
Silicate	6.8	0.2
Unclassified	5.9	0.1
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	66.4
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	66.3
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	751	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	22/07/04		

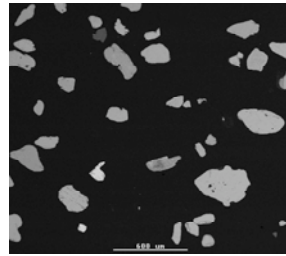


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	736	273	29240	557
Leucoxene	1.5	1.7	752	281	31602	145
Rutile	1.3	1.8	499	207	13150	4
Ti magnetite	1.3	1.0	128	49	1320	1
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.8	1.8	574	229	17241	22
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.6	1.6	577	208	19066	29
Silicate	1.6	1.7	752	287	33561	86
Unclassified	1.6	1.8	768	295	31935	77



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Sample Name:	2000752	No. of frames analysed	44
Lab. Name:	752	No. of particles analysed:	930
Date:	02/09/04	Heavy minerals in raw	
Submitter:	Stefan Bernstein	sand (%):	20.30
Country:	Madagascar	Comments:	
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	300 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	60.7	35.7	0.5	0.1	0.5	0.3	0.4	0.1	0.2	98.5
Leucoxene	75.1	21.2	0.3	0.1	0.6	0.5	0.2	0.1	0.2	98.4
Rutile	95.0	1.6	0.1	0.1	0.5	0.5	0.1	0.1	0.3	98.2
Ti magnetite	42.3	25.8	0.9	0.6	8.1	1.2	1.4	0.5	13.8	94.7
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	5.0	1.2	0.1	2.3	5.0	13.5
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kya/Sill	0.3	0.7	0.1	0.1	42.9	53.7	0.0	0.0	0.2	98.1
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.4	0.3	0.1	0.1	29.0	0.0	0.1	0.1	65.0	95.1
Silicate	1.2	1.2	0.1	0.1	53.5	41.5	0.0	0.1	0.3	98.0
Unclassified	6.5	8.0	0.1	0.2	2.3	58.7	18.7	0.5	2.8	97.9

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	83.6	6.4	1.3	0.3	0.0	7.8	0.5	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	61.7	76.3	96.8	44.6
Fe <sub>2</sub> O <sub>3</sub> wt%	36.2	21.6	1.6	27.3
MnO wt%	0.5	0.4	0.1	1.0
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.1	0.6
SiO <sub>2</sub> wt%	0.5	0.6	0.5	8.5
Al <sub>2</sub> O <sub>3</sub> wt%	0.3	0.5	0.5	1.2
MgO wt%	0.4	0.2	0.1	1.5
CaO wt%	0.1	0.1	0.1	0.6
ZrO <sub>2</sub> wt%	0.2	0.2	0.3	14.6
Total	100.0	100.0	100.0	100.0

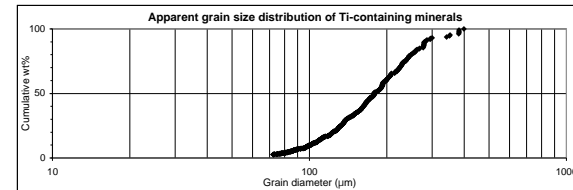
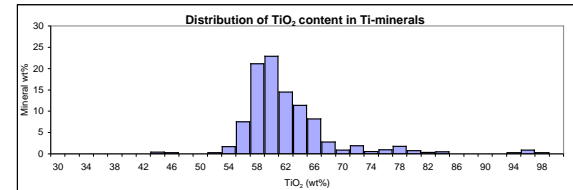
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	80.8	16.4
Leucoxene	6.2	1.3
Rutile	1.3	0.3
Ti magnetite	0.3	0.1
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.1	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	0.0	0.0
Kya/Sill	0.5	0.1
Staurolite	0.0	0.0
Zircon	7.5	1.5
Silicate	1.0	0.2
Unclassified	2.3	0.5
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	63.1
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	62.6
Valuable heavy minerals in raw sand:	19.61

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Lab. Name:	752	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage	17kV
Date:	02/09/04		

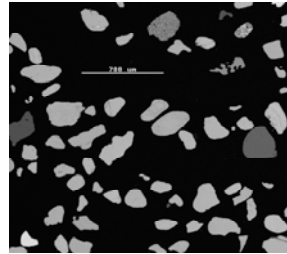


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.6	522	192	16026	715
Leucoxene	1.5	1.6	474	175	13717	64
Rutile	1.3	1.5	432	148	11776	14
Ti magnetite	1.6	2.4	487	216	8937	5
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	2.3	2.1	364	147	5056	2
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	0.0	0.0	0	0	0	0
Kya/Sill	1.8	2.1	527	210	11806	8
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.4	1.6	520	187	18391	56
Silicate	1.9	2.1	429	173	8341	28
Unclassified	1.4	1.9	732	286	29222	19



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Sample Name:	2000753	No. of frames analysed:	22
Lab. Name:	753	No. of particles analysed:	705
Date:	22/07/04	Heavy minerals in raw sand (%):	5.1
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	275 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	62.5	33.0	0.5	0.1	0.4	0.5	0.9	0.1	0.2	98.3
Leucoxene	72.8	23.3	0.3	0.1	0.4	0.6	0.5	0.2	0.2	98.5
Rutile	93.8	1.5	0.2	0.1	0.8	0.9	0.1	0.2	0.3	97.9
Ti magnetite	43.9	26.8	0.0	0.0	0.3	3.3	0.0	0.6	0.0	75.0
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.2	0.1	0.1	29.9	0.0	0.1	0.0	63.7	94.3
Silicate	0.3	0.5	0.1	0.1	74.9	19.4	1.1	0.6	0.1	97.0
Unclassified	3.4	9.5	0.1	0.3	6.7	50.9	12.7	0.5	6.7	90.9

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	86.5	7.3	2.8	0.0	0.0	3.4	0.0	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	63.6	73.9	95.8	58.6
Fe <sub>2</sub> O <sub>3</sub> wt%	33.6	23.7	1.6	35.8
MnO wt%	0.5	0.3	0.2	0.0
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.1	0.0
SiO <sub>2</sub> wt%	0.4	0.4	0.8	0.4
Al <sub>2</sub> O <sub>3</sub> wt%	0.5	0.6	0.9	4.4
MgO wt%	0.9	0.5	0.1	0.0
CaO wt%	0.1	0.2	0.2	0.8
ZrO <sub>2</sub> wt%	0.2	0.2	0.3	0.0
Total	100.0	100.0	100.0	100.0

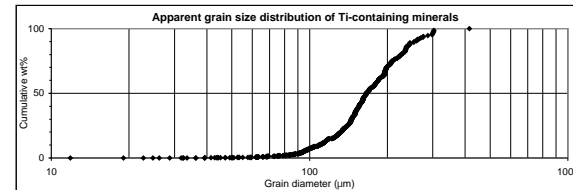
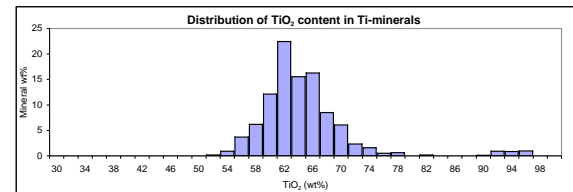
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	78.6	4.0
Leucoxene	6.6	0.3
Rutile	2.5	0.1
Ti magnetite	0.0	0.0
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	0.0	0.0
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	3.1	0.2
Silicate	3.3	0.2
Unclassified	5.9	0.3
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	65.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	64.4
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	753	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	22/07/04		

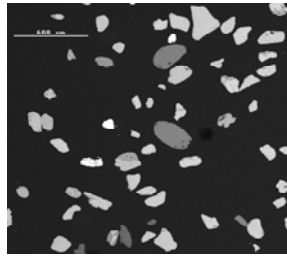


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.6	557	202	17009	543
Leucoxene	1.5	1.6	583	216	18154	43
Rutile	1.5	1.7	600	216	20687	13
Ti magnetite	1.2	0.9	69	28	406	1
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	0.0	0.0	0	0	0	0
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.4	1.6	607	221	19342	18
Silicate	1.5	1.8	552	217	17784	37
Unclassified	1.7	2.1	688	282	22967	50



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Sample Name:	2000754	No. of frames analysed:	34
Lab. Name:	754	No. of particles analysed:	885
Date:	02/09/04	Heavy minerals in raw sand (%):	16.00
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	400 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	57.8	38.3	0.5	0.1	0.5	0.5	0.5	0.1	0.2	98.4
Leucoxene	75.0	18.5	0.2	0.1	1.8	1.7	0.4	0.2	0.2	98.3
Rutile	91.4	3.1	0.1	0.0	2.5	0.8	0.1	0.1	0.2	98.5
Ti magnetite	40.7	34.3	1.3	0.2	1.4	1.8	0.7	0.3	2.1	82.9
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.2	0.0	0.0	3.8	0.3	0.2	3.4	7.6	15.5
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.4	27.8	0.7	0.1	38.2	18.6	5.2	7.3	0.2	98.5
Kya/Sill	0.2	1.1	0.1	0.2	43.0	53.8	0.0	0.1	0.2	98.7
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.3	0.4	0.1	0.1	28.9	0.0	0.1	0.1	65.1	95.1
Silicate	0.2	7.6	0.3	0.1	62.7	23.8	3.3	0.2	0.1	98.2
Unclassified	1.2	6.9	0.3	0.2	2.4	13.3	2.0	46.9	4.6	77.9

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	88.5	4.0	2.4	0.7	1.3	2.5	0.6	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	58.7	76.3	92.9	49.2
Fe <sub>2</sub> O <sub>3</sub> wt%	38.9	18.9	3.1	41.4
MnO wt%	0.5	0.2	0.1	1.6
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.0	0.2
SiO <sub>2</sub> wt%	0.5	1.8	2.6	1.7
Al <sub>2</sub> O <sub>3</sub> wt%	0.5	1.7	0.8	2.1
MgO wt%	0.5	0.5	0.1	0.9
CaO wt%	0.1	0.2	0.1	0.3
ZrO <sub>2</sub> wt%	0.2	0.2	0.2	2.6
Total	100.0	100.0	100.0	100.0

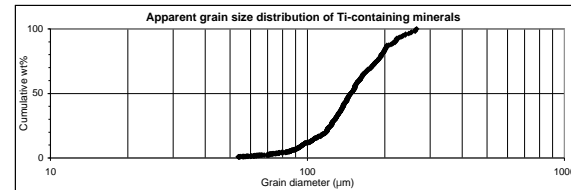
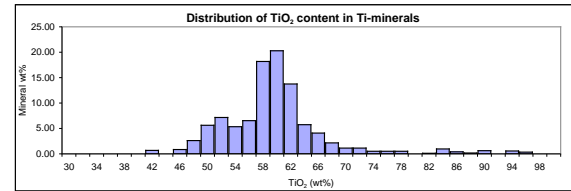
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	74.8	12.0
Leucoxene	3.4	0.5
Rutile	2.0	0.3
Ti magnetite	0.6	0.1
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.8	0.1
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	1.1	0.2
Kya/Sill	0.5	0.1
Staurolite	0.0	0.0
Zircon	2.2	0.3
Silicate	0.7	0.1
Unclassified	13.9	2.2
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	60.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	59.4
Valuable heavy minerals in raw sand:	13.53

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Lab. Name:	754	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	02/09/04		

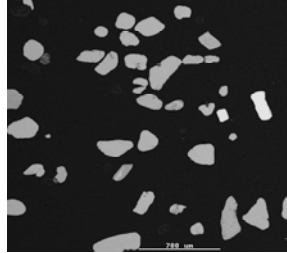


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.7	491	181	12833	656
Leucoxene	1.5	1.6	496	178	13660	28
Rutile	1.4	1.6	580	207	18568	11
Ti magnetite	1.3	1.6	389	155	9751	6
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.6	1.7	426	149	9446	9
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.4	1.6	354	132	6851	20
Kya/Sill	1.4	1.8	554	215	13686	6
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.5	1.5	411	141	9781	24
Silicate	1.6	1.7	548	202	15543	9
Unclassified	1.7	1.9	648	255	22387	116



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Sample Name:	2000755	No. of frames analysed:	36
Lab. Name:	755	No. of particles analysed:	784
Date:	19/07/04	Heavy minerals in raw sand (%):	8.0
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/400x		
Guard region:	275 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	64.0	31.1	0.5	0.1	0.7	0.4	0.8	0.1	0.2	97.9
Leucoxene	74.8	20.7	0.3	0.2	0.6	0.6	0.5	0.2	0.2	98.1
Rutile	94.4	1.9	0.1	0.1	0.6	0.4	0.1	0.1	0.1	97.8
Ti magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.2	0.3	0.2	0.2	29.2	0.0	0.1	0.1	64.4	94.6
Silicate	7.4	4.0	0.2	0.3	74.3	3.9	2.4	2.5	0.1	95.0
Unclassified	2.0	3.2	0.2	0.1	2.1	69.2	21.2	0.0	0.3	98.4

Valuable heavy minerals						
Category	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon
wt %	79.1	8.0	1.8	0.0	0.0	11.0

Normalised average contents of the valuable Ti-containing minerals:				
Average content	Category			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	65.3	76.2	96.4	0
Fe <sub>2</sub> O <sub>3</sub> wt%	31.7	21.1	2.0	0
MnO wt%	0.5	0.3	0.1	0
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.2	0.1	0
SiO <sub>2</sub> wt%	0.8	0.7	0.7	0
Al <sub>2</sub> O <sub>3</sub> wt%	0.4	0.7	0.4	0
MgO wt%	0.8	0.5	0.1	0
CaO wt%	0.1	0.2	0.1	0
ZrO <sub>2</sub> wt%	0.2	0.2	0.1	0
Total	100.0	100.0	100.0	0

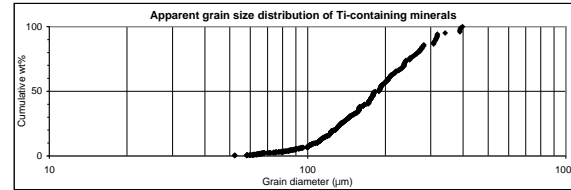
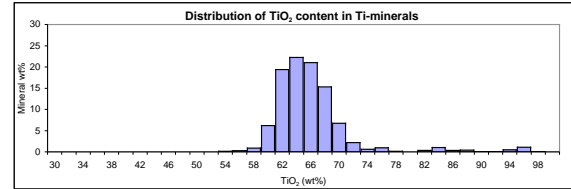
Weight percent on a mineral basis:		
Category	Heavy mineral concentrate	
	wt %	Raw sand wt %
Ilmenite	76.5	6.1
Leucoxene	7.8	0.6
Rutile	1.8	0.1
Ti magnetite	0.0	0.0
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	0.0	0.0
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	10.7	0.9
Silicate	0.0	0.0
Unclassified	3.3	0.3
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	66.9
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	66.3
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	755	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	19/07/04		

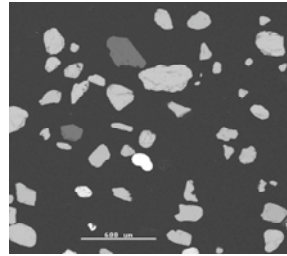


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.6	547	194	18380	581
Leucoxene	1.7	1.7	533	195	15457	70
Rutile	1.4	1.5	351	120	7680	29
Ti magnetite	0.0	0.0	0	0	0	0
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	0.0	0.0	0	0	0	0
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.4	1.6	578	213	20597	70
Silicate	1.3	1.1	122	44	1189	5
Unclassified	1.6	2.0	766	304	26273	29



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Sample Name:	2000756	No. of frames analysed:	42
Lab. Name:	756	No. of particles analysed:	1140
Date:	09/09/04	Heavy minerals in raw sand (%):	32.40
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	250 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	57.3	39.0	0.5	0.1	0.4	0.4	0.5	0.3	0.2	98.7
Leucoxene	74.1	19.9	0.2	0.1	2.2	1.7	0.2	0.3	0.1	99.0
Rutile	95.9	1.0	0.1	0.0	0.6	0.6	0.1	0.2	0.1	98.6
Ti magnetite	41.4	30.6	0.6	0.3	5.5	1.3	1.1	5.2	7.1	93.0
Magnetite	3.1	76.0	6.0	0.7	4.7	0.8	0.4	2.7	0.0	94.3
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	17.9	9.5	0.0	0.0	3.1	0.3	0.4	1.7	6.0	38.9
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.4	33.0	0.9	0.1	36.7	19.3	5.9	1.1	0.2	97.6
Kya/Sill	0.4	0.7	0.2	0.3	42.9	54.3	0.0	0.0	0.0	98.7
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.3	0.3	0.1	0.1	28.9	0.0	0.1	0.3	64.6	94.7
Silicate	1.1	11.5	0.1	0.2	43.2	35.0	2.6	3.8	0.3	97.7
Unclassified	3.0	9.9	0.1	0.3	3.3	17.9	3.2	5.7	8.8	52.1

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		Staurolite
wt %	91.0	1.0	1.0	1.1	0.5	5.1	0.2	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	58.0	74.9	97.2	44.5
Fe <sub>2</sub> O <sub>3</sub> wt%	39.5	20.1	1.0	32.9
MnO wt%	0.5	0.2	0.1	0.6
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.0	0.4
SiO <sub>2</sub> wt%	0.5	2.3	0.6	6.0
Al <sub>2</sub> O <sub>3</sub> wt%	0.4	1.7	0.6	1.4
MgO wt%	0.5	0.2	0.1	1.1
CaO wt%	0.3	0.3	0.2	5.6
ZrO <sub>2</sub> wt%	0.2	0.1	0.1	7.6
Total	100.0	100.0	100.0	100.0

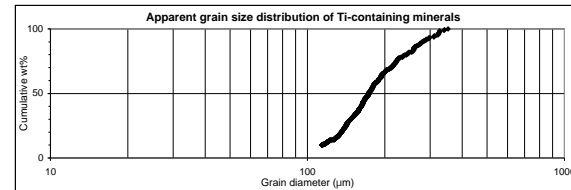
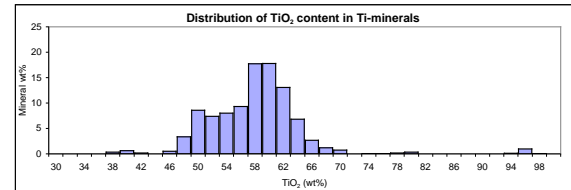
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	86.3	28.0
Leucoxene	1.0	0.3
Rutile	1.0	0.3
Ti magnetite	1.1	0.3
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.6	0.2
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	0.5	0.2
Kya/Sill	0.2	0.1
Staurolite	0.0	0.0
Zircon	4.8	1.6
Silicate	0.4	0.1
Unclassified	4.1	1.3
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	58.5
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	58.1
Valuable heavy minerals in raw sand:	30.72

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Lab. Name:	756	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	09/09/04		



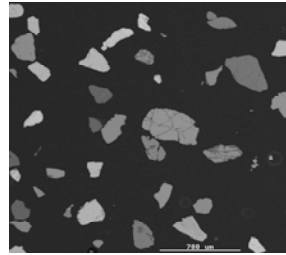
Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.7	570	210	17809	938
Leucoxene	1.4	1.6	630	230	20635	9
Rutile	1.6	1.8	505	188	14198	12
Ti magnetite	1.5	1.7	503	211	14819	13
Magnetite	1.3	1.0	139	52	1493	1
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	2.0	2.1	637	261	17162	6
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.5	1.7	469	179	11794	9
Kya/Sill	1.6	1.9	1165	457	57364	1
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.4	1.6	525	186	15325	59
Silicate	1.6	1.8	621	240	24054	6
Unclassified	1.5	1.8	552	214	16254	82





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Sample Name:	2000757	No. of frames analysed:	37
Lab. Name:	757	No. of particles analysed:	716
Date:	15/07/04	Heavy minerals in raw sand (%):	18.2
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	300 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	52.5	41.4	0.8	0.2	1.4	0.8	0.8	0.1	0.2	98.2
Leucoxene	72.3	12.9	0.3	0.2	8.1	3.4	0.4	0.5	0.2	98.3
Rutile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ti magnetite	31.4	55.4	0.7	0.1	5.2	3.1	1.2	0.4	0.3	97.8
Magnetite	2.1	88.7	0.3	0.3	2.4	2.8	0.5	0.2	0.4	97.7
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	29.9	1.3	0.0	0.1	35.4	5.1	0.2	25.9	0.2	97.8
Garnet	1.1	18.6	0.5	0.2	44.4	19.9	6.1	7.2	0.3	98.2
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.3	0.2	0.1	0.4	28.8	0.1	0.1	0.1	64.4	94.6
Silicate	0.8	6.7	0.2	0.1	59.5	12.7	8.3	8.3	0.2	96.6
Unclassified	2.0	12.8	0.8	0.4	4.4	44.4	7.7	9.0	4.7	86.1

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	44.0	4.9	0.0	6.4	44.0	0.6	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	53.5	73.5	0	32.1
Fe <sub>2</sub> O <sub>3</sub> wt%	42.2	13.1	0	56.6
MnO wt%	0.8	0.3	0	0.7
Cr <sub>2</sub> O <sub>3</sub> wt%	0.2	0.2	0	0.1
SiO <sub>2</sub> wt%	1.4	8.2	0	5.3
Al <sub>2</sub> O <sub>3</sub> wt%	0.8	3.5	0	3.2
MgO wt%	0.8	0.4	0	1.2
CaO wt%	0.1	0.5	0	0.5
ZrO <sub>2</sub> wt%	0.2	0.2	0	0.3
Total	100.0	100.0	0	100.0

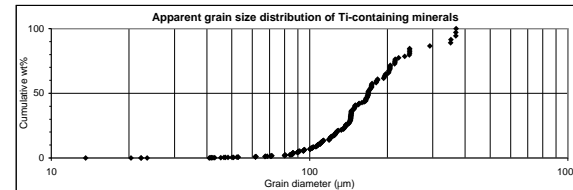
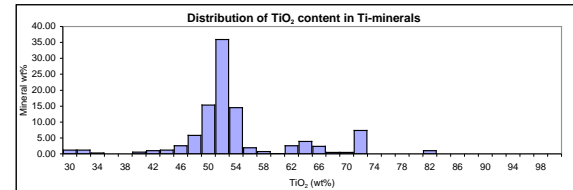
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	24.6	4.5
Leucoxene	2.8	0.5
Rutile	0.0	0.0
Ti magnetite	3.6	0.7
Magnetite	8.5	1.5
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.3	0.1
Garnet	24.6	4.5
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.4	0.1
Silicate	28.0	5.1
Unclassified	7.3	1.3
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	52.8
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	52.8
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	757	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	15/07/04		

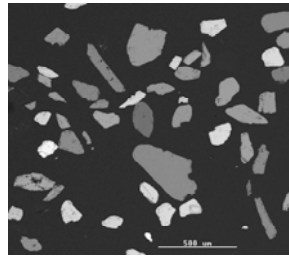


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.7	1.7	557	212	16441	185
Leucoxene	1.6	1.8	902	340	42491	8
Rutile	0.0	0.0	0	0	0	0
Ti magnetite	1.7	1.8	509	191	13013	32
Magnetite	1.5	1.6	457	167	11594	78
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	1.5	1.7	446	163	13623	4
Garnet	1.6	1.9	666	263	27351	125
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.4	1.3	324	108	8461	5
Silicate	1.7	1.9	719	283	27090	217
Unclassified	1.4	1.8	666	269	24242	62



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Sample Name:	2000758	No. of frames analysed:	52
Lab. Name:	758	No. of particles analysed:	905
Date:	07/09/04	Heavy minerals in raw sand (%):	12.70
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/50x		
Guard region:	350 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	51.5	43.3	0.9	0.1	1.2	0.7	0.6	0.3	0.2	98.7
Leucoxene	72.6	9.7	0.2	0.1	8.4	3.9	2.5	0.4	0.3	98.2
Rutile	91.1	5.3	0.2	0.1	1.4	0.8	0.1	0.1	0.1	99.2
Ti magnetite	38.0	52.3	0.9	0.1	3.2	2.4	1.1	0.4	0.2	98.6
Magnetite	7.4	84.7	0.1	0.2	3.1	2.2	0.3	0.2	0.2	98.3
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	4.5	0.0	0.0	7.9	4.3	2.0	2.8	6.3	27.8
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	37.0	1.2	0.1	0.1	28.8	2.6	0.1	27.9	0.3	98.3
Garnet	0.3	27.2	0.8	0.1	39.3	17.1	6.7	6.4	0.3	98.2
Kya/Sill	0.1	2.0	0.1	0.1	42.6	53.4	0.0	0.1	0.1	98.5
Staurolite	3.4	9.2	0.1	0.3	36.2	47.3	0.1	0.4	0.4	97.4
Zircon	0.2	0.5	0.3	0.1	29.0	0.1	0.1	0.5	65.0	95.6
Silicate	1.6	12.4	0.3	0.2	48.8	13.8	9.0	10.3	0.2	96.5
Unclassified	3.8	9.5	0.3	0.3	6.3	14.7	3.1	52.9	1.3	92.4

Valuable heavy minerals									
Category	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	Staurolite	Total
wt %	42.0	2.2	0.5	14.8	34.5	2.3	3.4	0.4	100.0

Normalised average contents of the valuable Ti-containing minerals:				
Average content	Category			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	52.2	74.0	91.9	38.5
Fe <sub>2</sub> O <sub>3</sub> wt%	43.8	9.8	5.3	53.1
MnO wt%	0.9	0.2	0.2	1.0
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.1	0.1	0.1
SiO <sub>2</sub> wt%	1.2	8.6	1.4	3.2
Al <sub>2</sub> O <sub>3</sub> wt%	0.7	4.0	0.8	2.4
MgO wt%	0.6	2.6	0.1	1.1
CaO wt%	0.3	0.5	0.1	0.4
ZrO <sub>2</sub> wt%	0.2	0.3	0.1	0.2
Total	100.0	100.0	100.0	100.0

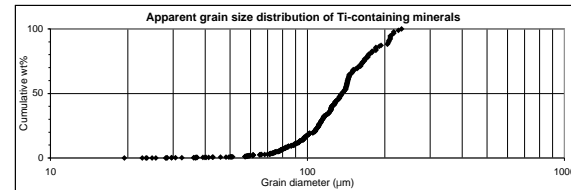
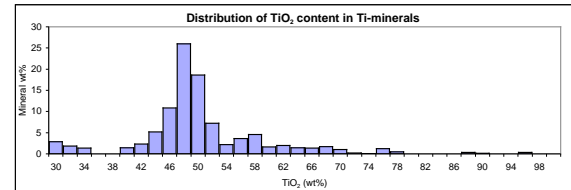
Weight percent on a mineral basis:		
Category	Heavy mineral concentrate	
	wt %	Raw sand wt %
Ilmenite	28.3	3.6
Leucoxene	1.5	0.2
Rutile	0.3	0.0
Ti magnetite	9.9	1.3
Magnetite	0.2	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.4	0.0
Y-phosphate	0.0	0.0
Sphene	1.1	0.1
Garnet	23.3	3.0
Kya/Sill	2.3	0.3
Staurolite	0.3	0.0
Zircon	1.5	0.2
Silicate	16.7	2.1
Unclassified	14.2	1.8
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	49.9
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	49.6
Valuable heavy minerals in raw sand:	8.56

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Lab. Name:	758	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	07/09/04		

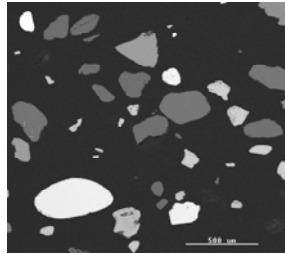


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	440	163	10161	260
Leucoxene	1.5	1.7	394	146	9157	15
Rutile	1.8	2.1	482	196	9105	3
Ti magnetite	1.7	2.0	536	211	13044	67
Magnetite	1.4	1.6	280	104	4385	4
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.6	1.7	387	152	7793	4
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	1.4	1.7	482	179	12139	11
Garnet	1.8	2.0	535	214	13502	181
Kya/Sill	2.2	2.5	787	329	21227	14
Staurolite	1.2	1.4	238	100	5654	5
Zircon	1.4	1.5	411	139	9990	14
Silicate	1.6	1.8	496	194	13205	201
Unclassified	2.1	2.5	682	290	17550	126



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Sample Name:	2000759	No. of frames analysed:	33
Lab. Name:	759	No. of particles analysed:	697
Date:	12/08/04	Heavy minerals in raw sand (%):	2.5
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/50x		
Guard region:	275 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	50.5	42.6	0.8	0.1	2.2	1.3	0.6	0.1	0.2	98.5
Leucoxene	71.4	9.9	0.2	0.2	9.7	6.1	0.2	0.3	0.3	98.3
Rutile	95.6	0.2	0.3	0.4	1.0	0.4	0.1	0.0	0.8	98.8
Ti magnetite	36.8	51.5	0.8	0.2	4.0	2.7	0.9	0.2	0.3	97.2
Magnetite	2.9	82.8	0.7	0.3	8.1	2.5	0.6	0.4	0.2	98.5
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.4	0.0	0.0	7.3	1.2	0.1	1.9	3.3	14.3
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	32.3	1.5	0.0	0.2	31.8	4.6	0.2	27.6	0.6	98.7
Garnet	1.3	18.4	0.9	0.1	40.6	19.9	4.2	10.9	0.9	97.2
Kya/Sill	0.1	1.4	0.1	0.1	42.9	53.4	0.0	0.1	0.0	98.2
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.6	0.7	0.1	0.1	29.5	0.3	0.1	0.1	63.8	95.3
Silicate	0.4	2.4	0.2	0.1	49.9	42.3	0.7	1.0	0.1	97.0
Unclassified	4.7	13.6	0.3	0.3	8.1	47.9	9.8	0.4	3.7	88.7

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	61.3	2.3	0.6	13.6	9.9	8.9	3.4	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	51.3	72.7	96.8	37.9
Fe <sub>2</sub> O <sub>3</sub> wt%	43.3	10.1	0.2	53.0
MnO wt%	0.8	0.2	0.3	0.8
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.2	0.4	0.2
SiO <sub>2</sub> wt%	2.2	9.8	1.0	4.1
Al <sub>2</sub> O <sub>3</sub> wt%	1.3	6.2	0.4	2.8
MgO wt%	0.6	0.2	0.1	0.9
CaO wt%	0.1	0.3	0.0	0.2
ZrO <sub>2</sub> wt%	0.2	0.3	0.8	0.3
Total	100.0	100.0	100.0	100.0

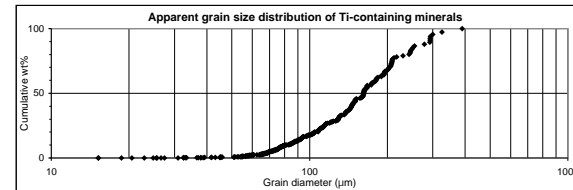
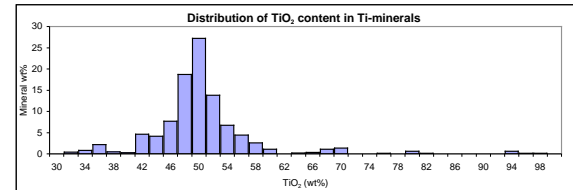
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	50.0
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	49.6
Valuable heavy minerals in raw sand:	0.00

Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	45.6	1.2
Leucoxene	1.7	0.0
Rutile	0.5	0.0
Ti magnetite	10.1	0.3
Magnetite	0.7	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	1.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.4	0.0
Garnet	7.4	0.2
Kya/Sill	2.5	0.1
Staurolite	0.0	0.0
Zircon	6.6	0.2
Silicate	17.4	0.4
Unclassified	6.1	0.2
Total	100.0	

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Lab. Name:	759	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	12/08/04		

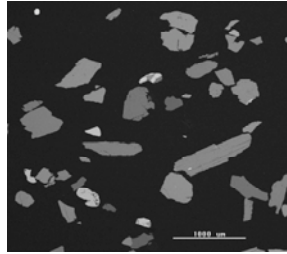


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.6	452	165	12489	286
Leucoxene	1.7	1.6	446	167	11232	12
Rutile	1.2	1.5	436	157	11044	3
Ti magnetite	1.6	1.7	422	157	10790	69
Magnetite	2.1	1.9	391	156	7886	6
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.8	1.5	576	199	18042	4
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	1.6	1.9	575	228	13801	3
Garnet	1.6	1.8	450	176	12493	52
Kya/Sill	1.6	1.9	775	304	27029	10
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.5	1.6	490	177	15614	32
Silicate	1.6	1.7	487	185	14051	165
Unclassified	1.6	1.7	472	179	14547	55



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Sample Name:	2000761	No. of frames analysed:	31
Lab. Name:	761	No. of particles analysed:	798
Date:	11/08/04	Heavy minerals in raw sand (%):	12.3
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/25x		
Guard region:	500 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	52.3	38.7	0.6	0.1	3.8	1.3	0.7	0.1	0.2	97.7
Leucoxene	69.0	6.4	0.5	0.2	15.8	1.6	4.6	0.5	0.0	98.6
Rutile	96.9	0.2	0.1	0.1	0.4	0.3	0.1	0.1	0.3	98.5
Ti magnetite	31.6	37.5	0.2	0.5	5.8	4.6	3.5	0.8	0.0	84.5
Magnetite	0.5	56.7	0.3	0.1	23.3	12.4	0.3	1.5	0.6	95.6
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.2	0.6	0.1	0.0	0.0	0.0	50.0	2.8	53.9
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	36.4	1.0	0.1	0.1	31.8	2.4	0.2	25.8	0.2	98.0
Garnet	0.5	24.1	1.0	0.1	41.6	20.5	7.3	2.5	0.2	97.9
Kya/Sill	0.2	0.5	0.0	0.1	42.9	53.4	0.0	0.0	0.6	97.7
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.6	0.2	0.2	28.9	0.3	0.2	0.1	64.5	95.2
Silicate	0.8	13.8	0.3	0.2	53.3	7.1	12.9	7.4	0.1	96.0
Unclassified	2.5	7.0	1.3	1.3	20.8	7.2	8.8	12.9	4.8	66.7

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	17.1	0.9	1.8	1.1	77.9	1.0	0.1	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	53.5	70.0	98.4	37.4
Fe <sub>2</sub> O <sub>3</sub> wt%	39.6	6.5	0.2	44.4
MnO wt%	0.6	0.5	0.1	0.3
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.2	0.1	0.6
SiO <sub>2</sub> wt%	3.9	16.0	0.4	6.9
Al <sub>2</sub> O <sub>3</sub> wt%	1.3	1.6	0.3	5.5
MgO wt%	0.7	4.7	0.1	4.1
CaO wt%	0.1	0.5	0.1	0.9
ZrO <sub>2</sub> wt%	0.2	0.0	0.3	0.0
Total	100.0	100.0	100.0	100.0

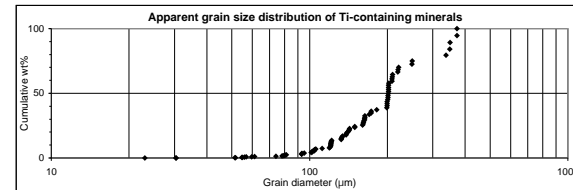
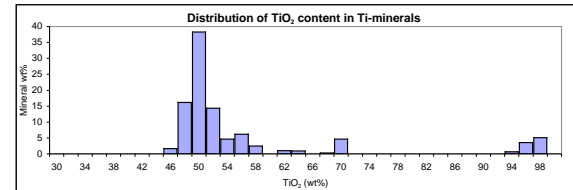
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	7.2	0.9
Leucoxene	0.4	0.0
Rutile	0.8	0.1
Ti magnetite	0.5	0.1
Magnetite	0.6	0.1
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.9	0.1
Garnet	32.9	4.1
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.4	0.1
Silicate	52.9	6.5
Unclassified	3.3	0.4
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	57.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	53.4
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	761	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	11/08/04		

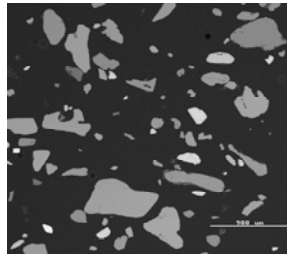


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.7	1.6	623	232	21969	75
Leucoxene	1.2	2.5	1669	708	89478	1
Rutile	1.5	1.5	474	160	12319	13
Ti magnetite	1.5	1.6	711	297	33746	3
Magnetite	1.9	2.6	1316	563	54428	2
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	2.0	1.4	339	112	6444	1
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	1.5	1.8	696	262	22634	12
Garnet	1.7	1.9	947	378	46481	182
Kya/Sill	1.9	1.8	543	207	13394	1
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.2	1.2	360	115	8496	11
Silicate	1.7	1.8	910	356	47170	435
Unclassified	1.5	1.5	544	214	27768	45



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Sample Name:	2000763	No. of frames analysed	21
Lab. Name:	763	No. of particles analysed:	795
Date:	14/07/04	Heavy minerals in raw sand (%):	3.3
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/30x		
Guard region:	500 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	52.5	37.2	0.8	0.2	2.5	1.2	1.4	1.2	0.5	97.4
Leucoxene	77.3	6.0	0.2	0.2	6.5	5.1	0.3	0.8	0.5	96.9
Rutile	94.3	0.3	0.2	0.2	1.0	0.7	0.3	0.2	0.4	97.7
Ti magnetite	40.6	41.0	0.6	0.1	7.2	1.8	1.7	2.3	0.7	96.0
Magnetite	0.8	73.1	1.6	1.0	6.8	1.0	1.4	0.9	0.1	86.8
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	29.4	0.7	0.1	0.1	35.2	4.7	0.3	27.2	0.6	98.3
Garnet	0.4	19.4	0.8	0.1	44.2	21.7	7.1	4.1	0.2	98.1
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.2	1.0	0.2	0.2	29.2	0.6	0.6	0.5	62.0	94.4
Silicate	0.9	8.8	0.2	0.2	51.3	15.6	10.7	8.5	0.2	96.4
Unclassified	7.1	8.1	0.5	0.3	9.4	22.4	4.3	40.6	0.3	93.1

Valuable heavy minerals									
Category	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	Staurolite	Total
wt %	13.1	0.9	0.9	1.6	81.7	1.9	0.0	0.0	100.0

Normalised average contents of the valuable Ti-containing minerals:				
Average content	Category			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	53.9	79.7	96.6	42.3
Fe <sub>2</sub> O <sub>3</sub> wt%	38.2	6.2	0.3	42.7
MnO wt%	0.8	0.2	0.2	0.7
Cr <sub>2</sub> O <sub>3</sub> wt%	0.2	0.2	0.2	0.1
SiO <sub>2</sub> wt%	2.6	6.7	1.1	7.5
Al <sub>2</sub> O <sub>3</sub> wt%	1.2	5.2	0.7	1.8
MgO wt%	1.4	0.3	0.3	1.7
CaO wt%	1.2	0.9	0.2	2.4
ZrO <sub>2</sub> wt%	0.5	0.6	0.4	0.8
Total	100.0	100.0	100.0	100.0

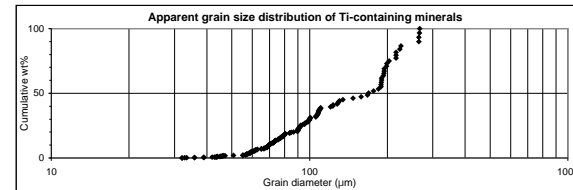
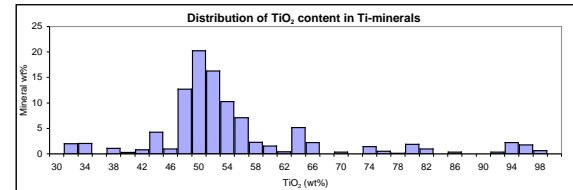
Weight percent on a mineral basis:		
Category	Heavy mineral concentrate	
	wt %	Raw sand wt %
Ilmenite	8.7	0.3
Leucoxene	0.6	0.0
Rutile	0.6	0.0
Ti magnetite	1.0	0.0
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.1	0.0
Garnet	54.0	1.8
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	1.3	0.0
Silicate	21.3	0.7
Unclassified	12.4	0.4
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	56.4
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	54.2
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	763	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	14/07/04		

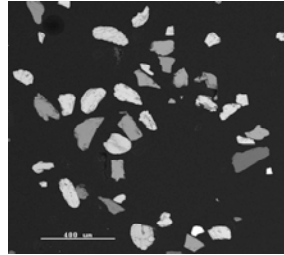


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.5	375	131	9681	136
Leucoxene	1.6	1.5	344	120	6672	13
Rutile	2.0	1.6	370	133	7042	11
Ti magnetite	1.3	1.5	361	129	9321	16
Magnetite	1.4	1.3	126	43	1191	4
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	2.2	1.9	375	147	5947	4
Garnet	1.8	1.8	756	298	33788	273
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.3	1.6	671	261	26396	7
Silicate	1.7	1.6	530	195	21287	258
Unclassified	1.7	1.7	750	302	42990	73



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Sample Name:	2000764	No. of frames analysed:	64
Lab. Name:	764	No. of particles analysed:	1587
Date:	02/09/04	Heavy minerals in raw sand (%):	37.20
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/60x		
Guard region:	150 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	51.1	44.6	0.8	0.1	0.8	0.4	0.6	0.2	0.2	98.7
Leucoxene	75.8	8.6	0.2	0.2	4.5	2.4	1.1	4.7	0.1	97.6
Rutile	95.0	0.9	0.2	0.1	0.9	0.6	0.1	0.2	0.2	98.4
Ti magnetite	39.5	50.7	0.8	0.1	2.9	2.0	1.1	0.7	0.3	98.0
Magnetite	1.0	79.1	1.9	0.1	6.6	2.5	1.3	2.5	0.6	95.6
Chromite	4.1	31.5	0.5	42.8	0.9	8.9	10.1	0.2	0.4	99.3
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.3	0.0	0.0	3.7	0.3	0.2	1.9	6.9	13.2
Y-phosphate	0.0	0.1	0.0	0.0	2.2	0.7	0.5	3.7	7.3	14.5
Sphene	38.7	2.0	0.1	0.1	25.8	2.6	0.2	28.2	0.4	98.2
Garnet	0.5	29.4	1.1	0.1	37.9	18.6	6.1	4.7	0.2	98.5
Kya/Sill	0.2	1.9	0.0	0.1	42.9	53.4	0.0	0.1	0.1	98.7
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.2	0.6	0.1	0.1	29.3	0.1	0.1	0.1	65.0	95.6
Silicate	1.4	9.0	0.2	0.1	58.0	16.3	5.2	6.3	0.1	96.6
Unclassified	1.9	9.1	0.4	0.2	5.6	16.7	4.6	43.3	3.5	85.3

Valuable heavy minerals									
Category	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	Staurolite	Total
wt %	52.3	0.5	2.0	7.8	30.7	5.3	1.3	0.0	100.0

Normalised average contents of the valuable Ti-containing minerals:				
Average content	Category			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	51.7	77.6	96.6	40.3
Fe <sub>2</sub> O <sub>3</sub> wt%	45.1	8.8	1.0	51.7
MnO wt%	0.8	0.2	0.2	0.8
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.2	0.1	0.1
SiO <sub>2</sub> wt%	0.8	4.6	1.0	2.9
Al <sub>2</sub> O <sub>3</sub> wt%	0.4	2.5	0.6	2.0
MgO wt%	0.6	1.1	0.1	1.1
CaO wt%	0.2	4.8	0.2	0.7
ZrO <sub>2</sub> wt%	0.2	0.1	0.2	0.3
Total	100.0	100.0	100.0	100.0

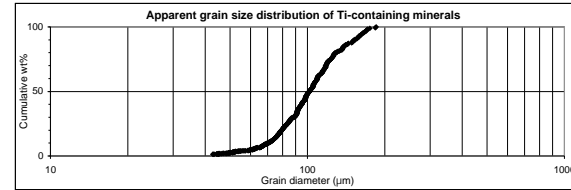
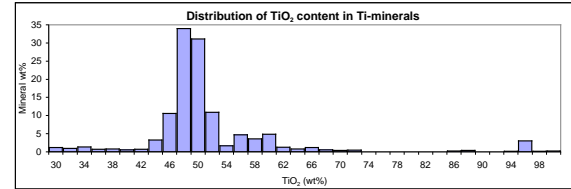
Weight percent on a mineral basis:		
Category	Heavy mineral concentrate	
	wt %	Raw sand wt %
Ilmenite	39.6	14.7
Leucoxene	0.4	0.1
Rutile	1.5	0.6
Ti magnetite	5.9	2.2
Magnetite	0.1	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.5	0.2
Y-phosphate	0.1	0.0
Sphene	1.1	0.4
Garnet	23.3	8.6
Kya/Sill	1.0	0.4
Staurolite	0.0	0.0
Zircon	4.0	1.5
Silicate	15.9	5.9
Unclassified	6.6	2.5
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	52.0
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	50.5
Valuable heavy minerals in raw sand:	28.13

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Lab. Name:	764	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	02/09/04		

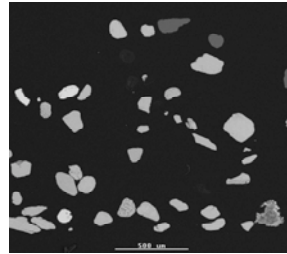


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.6	337	122	6243	613
Leucoxene	1.6	1.6	262	98	3789	9
Rutile	1.6	1.7	332	125	5627	24
Ti magnetite	1.6	1.8	377	146	6800	79
Magnetite	1.4	1.3	98	35	823	9
Chromite	1.1	1.2	259	77	4347	1
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.8	1.5	301	104	4931	9
Y-phosphate	1.6	1.4	290	91	4993	2
Sphene	1.6	1.8	466	180	10279	13
Garnet	1.6	1.9	395	156	7316	343
Kya/Sill	1.3	1.9	490	192	10523	12
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.5	1.6	334	119	5977	61
Silicate	1.6	1.9	459	180	10171	256
Unclassified	1.8	2.1	402	162	7428	144



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Sample Name:	2000765	No. of frames analysed:	50
Lab. Name:	765	No. of particles analysed:	824
Date:	13/07/04	Heavy minerals in raw sand (%):	2.3
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/50x		
Guard region:	250 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	55.0	37.8	0.9	0.1	2.1	1.5	0.9	0.1	0.2	98.5
Leucoxene	73.3	13.0	0.4	0.2	6.1	4.4	0.4	0.3	0.3	98.3
Rutile	94.8	0.7	0.2	0.1	1.8	0.8	0.0	0.1	0.2	98.7
Ti magnetite	40.0	31.1	0.6	0.3	12.2	13.8	0.6	0.1	0.2	98.8
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	8.0	2.2	0.1	1.5	6.3	18.1
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.6	13.8	0.3	0.1	43.9	23.5	2.2	13.3	0.1	97.9
Kya/Sill	0.1	1.2	0.1	0.1	42.9	53.2	0.0	0.1	0.0	97.8
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.3	0.1	0.1	29.4	0.2	0.1	0.1	64.0	94.4
Silicate	0.2	1.2	0.1	0.1	51.3	44.9	0.1	0.3	0.1	98.4
Unclassified	2.9	7.7	0.2	0.1	5.4	55.1	15.7	0.6	3.5	91.2

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	89.7	1.7	0.5	0.7	1.2	5.8	0.4	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	55.8	74.6	96.0	40.5
Fe <sub>2</sub> O <sub>3</sub> wt%	38.3	13.2	0.7	31.4
MnO wt%	0.9	0.4	0.2	0.6
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.2	0.1	0.3
SiO <sub>2</sub> wt%	2.1	6.2	1.8	12.3
Al <sub>2</sub> O <sub>3</sub> wt%	1.5	4.5	0.8	13.9
MgO wt%	0.9	0.4	0.0	0.6
CaO wt%	0.1	0.3	0.1	0.1
ZrO <sub>2</sub> wt%	0.2	0.3	0.2	0.2
Total	100.0	100.0	100.0	100.0

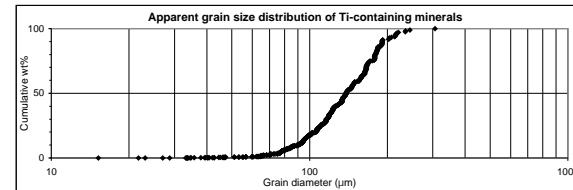
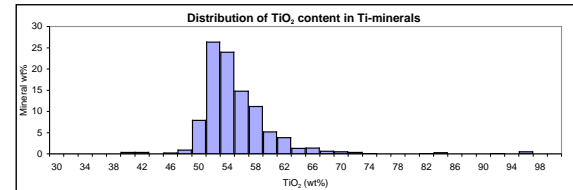
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	75.9	1.7
Leucoxene	1.4	0.0
Rutile	0.4	0.0
Ti magnetite	0.6	0.0
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	1.0	0.0
Kya/Sill	0.4	0.0
Staurolite	0.0	0.0
Zircon	4.9	0.1
Silicate	11.0	0.3
Unclassified	4.4	0.1
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	56.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	56.0
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	765	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	13/07/04		

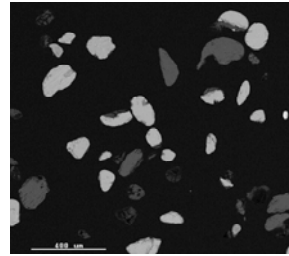


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.6	454	162	11629	576
Leucoxene	1.4	1.5	340	116	6858	18
Rutile	1.5	1.5	391	129	8759	4
Ti magnetite	1.6	2.2	610	255	15768	3
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.3	1.3	134	35	1125	1
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.8	1.6	347	133	9434	11
Kya/Sill	1.7	1.8	519	197	14528	3
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.4	1.5	389	128	9932	42
Silicate	1.6	1.7	487	184	13748	120
Unclassified	1.5	1.8	527	199	14191	46



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Sample Name:	2000766	No. of frames analysed:	36
Lab. Name:	766	No. of particles analysed:	842
Date:	2004+09-03	Heavy minerals in raw sand (%):	3.70
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/60x		
Guard region:	200 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	54.9	34.9	0.8	0.1	4.3	2.6	0.6	0.1	0.2	98.5
Leucoxene	74.3	9.0	0.3	0.2	8.3	5.5	0.2	0.2	0.2	98.1
Rutile	92.4	1.5	0.0	0.1	2.6	1.3	0.1	0.2	0.1	98.3
Ti magnetite	33.6	32.1	0.9	0.1	19.1	7.9	0.5	0.7	0.4	95.4
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.1	0.0	0.0	7.6	2.5	0.1	2.7	6.3	19.1
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	9.4	15.7	0.4	0.3	43.5	17.4	0.6	0.4	2.3	90.1
Kya/Sill	0.2	2.4	0.1	0.0	43.1	53.4	0.0	0.0	0.0	99.2
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.4	0.6	0.1	0.0	30.5	1.1	0.1	0.1	62.5	95.5
Silicate	3.4	7.0	0.3	0.2	56.7	25.6	0.8	0.4	0.5	94.9
Unclassified	7.3	14.1	0.8	0.7	30.1	27.5	5.3	0.5	6.4	92.7

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		
wt %	87.6	3.2	2.6	0.2	0.4	5.6	0.4	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	55.8	75.7	94.0	35.2
Fe <sub>2</sub> O <sub>3</sub> wt%	35.5	9.2	1.6	33.7
MnO wt%	0.8	0.3	0.0	0.9
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.2	0.1	0.1
SiO <sub>2</sub> wt%	4.4	8.5	2.6	20.0
Al <sub>2</sub> O <sub>3</sub> wt%	2.6	5.7	1.3	8.3
MgO wt%	0.6	0.2	0.1	0.5
CaO wt%	0.1	0.2	0.2	0.7
ZrO <sub>2</sub> wt%	0.2	0.2	0.1	0.4
Total	100.0	100.0	100.0	100.0

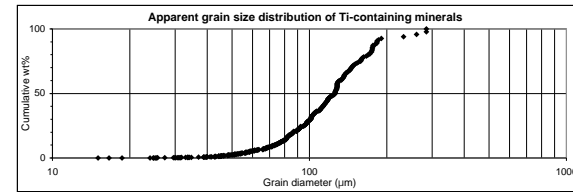
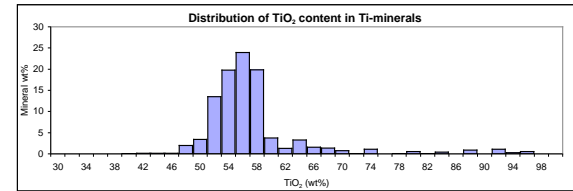
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	71.5	2.6
Leucoxene	2.6	0.1
Rutile	2.1	0.1
Ti magnetite	0.2	0.0
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.8	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	0.3	0.0
Kya/Sill	0.3	0.0
Staurolite	0.0	0.0
Zircon	4.6	0.2
Silicate	12.5	0.5
Unclassified	5.0	0.2
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	57.4
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	56.4
Valuable heavy minerals in raw sand:	3.02

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Lab. Name:	766	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	2004+09-03		



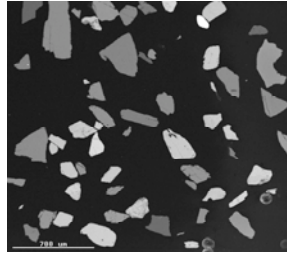
Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.6	376	137	8051	347
Leucoxene	1.6	1.8	365	138	6792	15
Rutile	1.7	1.8	546	207	14897	5
Ti magnetite	1.5	1.4	112	39	771	8
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.4	1.6	436	158	9514	3
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.3	1.3	87	35	562	24
Kya/Sill	2.3	2.4	513	216	8770	2
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.5	1.6	363	132	7572	23
Silicate	1.4	1.6	173	67	2332	355
Unclassified	1.4	1.4	226	87	5454	60





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Sample Name:	2000767	No. of frames analysed:	49
Lab. Name:	767	No. of particles analysed:	852
Date:	21/07/04	Heavy minerals in raw sand (%):	38.2
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	350 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	52.5	40.9	0.9	0.2	1.3	0.6	1.4	0.1	0.3	98.1
Leucoxene	72.2	11.6	0.3	0.6	6.8	1.9	1.8	0.2	0.1	95.5
Rutile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ti magnetite	32.4	56.7	0.4	0.2	4.4	1.6	1.6	0.4	0.2	98.0
Magnetite	0.5	83.8	0.3	0.5	7.1	3.5	0.6	0.2	0.4	96.9
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	31.0	0.6	0.3	0.2	36.4	3.9	0.1	25.4	0.3	98.3
Garnet	0.3	18.0	1.0	0.1	45.9	22.6	7.0	3.1	0.2	98.2
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.6	0.2	0.2	29.4	0.0	0.2	0.1	63.6	94.5
Silicate	0.8	8.6	0.3	0.2	54.3	13.7	9.9	7.2	0.2	95.1
Unclassified	3.9	8.1	0.5	0.6	11.2	6.3	3.4	22.1	6.9	63.2

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	48.1	0.4	0.0	15.2	34.8	1.5	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	53.5	75.5	0	33.0
Fe <sub>2</sub> O <sub>3</sub> wt%	41.7	12.2	0	57.9
MnO wt%	0.9	0.3	0	0.4
Cr <sub>2</sub> O <sub>3</sub> wt%	0.2	0.7	0	0.2
SiO <sub>2</sub> wt%	1.3	7.1	0	4.5
Al <sub>2</sub> O <sub>3</sub> wt%	0.6	2.0	0	1.7
MgO wt%	1.4	1.9	0	1.7
CaO wt%	0.1	0.2	0	0.4
ZrO <sub>2</sub> wt%	0.3	0.1	0	0.2
Total	100.0	100.0	0	100.0

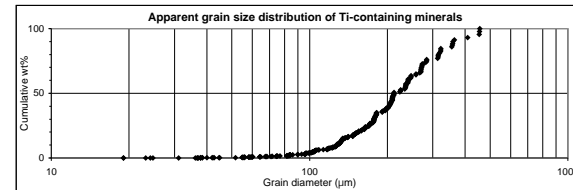
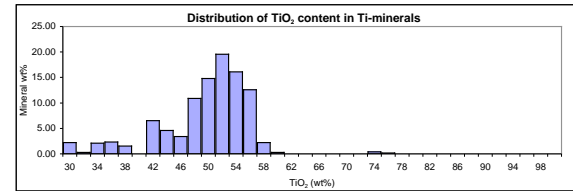
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	34.3	13.1
Leucoxene	0.3	0.1
Rutile	0.0	0.0
Ti magnetite	10.8	4.1
Magnetite	4.5	1.7
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.6	0.2
Garnet	24.8	9.5
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	1.1	0.4
Silicate	21.0	8.0
Unclassified	2.6	1.0
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	48.7
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	48.7
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	767	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	21/07/04		

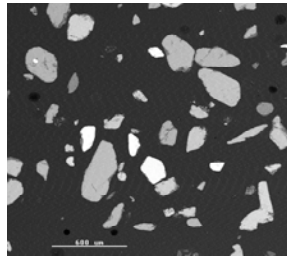


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.8	628	239	21327	268
Leucoxene	1.4	1.6	384	145	8530	5
Rutile	0.0	0.0	0	0	0	0
Ti magnetite	1.7	2.0	915	365	42374	40
Magnetite	1.4	1.6	555	208	17517	37
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	1.6	1.4	624	204	21959	6
Garnet	1.7	2.0	748	302	26892	173
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.6	1.5	405	138	11123	16
Silicate	2.0	2.2	682	281	22844	260
Unclassified	1.7	2.0	573	234	15314	47



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Sample Name:	2000768	No. of frames analysed	64
Lab. Name:	768	No. of particles analysed:	1609
Date:	07/09/04	Heavy minerals in raw sand (%):	6.00
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	350 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	53.4	38.2	0.6	0.2	2.3	1.2	0.7	1.6	0.2	98.5
Leucoxene	75.4	11.5	0.2	0.3	5.2	3.4	0.4	2.0	0.2	98.6
Rutile	92.9	0.9	0.1	0.2	1.9	0.8	0.2	1.5	0.2	98.6
Ti magnetite	39.9	47.3	0.8	0.2	3.5	1.5	0.9	4.0	0.2	98.3
Magnetite	0.4	88.3	0.2	0.2	4.0	2.9	0.4	1.5	0.2	98.2
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.4	0.0	0.0	3.9	1.1	0.2	4.2	7.2	17.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	38.2	0.4	0.1	0.2	28.5	2.5	0.0	27.9	0.5	98.3
Garnet	0.3	24.7	1.2	0.2	38.8	15.8	6.4	10.3	0.2	97.8
Kya/Sill	0.2	1.8	0.2	0.0	42.6	53.1	0.0	0.4	0.5	98.8
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.2	0.7	0.2	0.1	29.2	0.3	0.1	1.6	63.1	95.4
Silicate	1.3	15.9	0.3	0.2	42.9	12.7	8.7	13.4	0.2	95.7
Unclassified	2.0	10.1	0.4	0.4	15.5	9.5	2.6	48.9	1.9	91.3

Category	Valuable heavy minerals							Total	
	wt %	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon		
wt %	27.8	0.7	1.8	12.7	54.8	2.0	0.1	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Category	Ilmenite	Leucoxene	Rutile
TiO <sub>2</sub> wt%	54.2	76.5	94.2	40.6
Fe <sub>2</sub> O <sub>3</sub> wt%	38.8	11.6	1.0	48.1
MnO wt%	0.7	0.2	0.1	0.8
Cr <sub>2</sub> O <sub>3</sub> wt%	0.2	0.3	0.2	0.2
SiO <sub>2</sub> wt%	2.4	5.2	1.9	3.6
Al <sub>2</sub> O <sub>3</sub> wt%	1.2	3.5	0.8	1.5
MgO wt%	0.7	0.4	0.2	0.9
CaO wt%	1.7	2.1	1.5	4.0
ZrO <sub>2</sub> wt%	0.2	0.2	0.2	0.2
Total	100.0	100.0	100.0	100.0

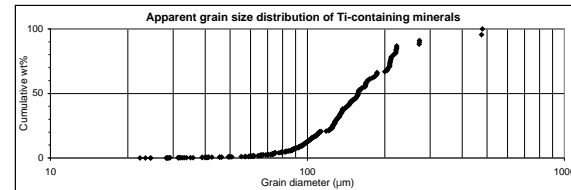
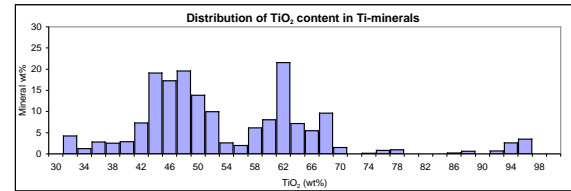
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	16.0	1.0
Leucoxene	0.4	0.0
Rutile	1.1	0.1
Ti magnetite	7.3	0.4
Magnetite	2.6	0.2
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.1	0.0
Y-phosphate	0.0	0.0
Sphene	0.5	0.0
Garnet	31.6	1.9
Kya/Sill	0.1	0.0
Staurolite	0.0	0.0
Zircon	1.2	0.1
Silicate	33.2	2.0
Unclassified	5.9	0.4
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	52.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	50.4
Valuable heavy minerals in raw sand:	3.46

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Lab. Name:	768	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage	17kV
Date:	07/09/04		

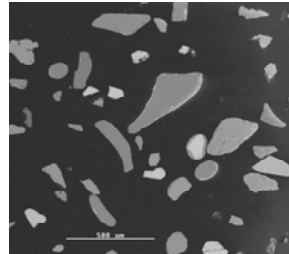


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.6	488	176	15239	172
Leucoxene	1.3	1.4	399	131	9529	7
Rutile	1.8	1.7	490	185	12248	13
Ti magnetite	1.6	1.8	461	175	11197	99
Magnetite	1.4	1.6	452	163	11101	31
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	1.4	1.3	324	104	7230	2
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	1.1	1.5	820	277	36748	3
Garnet	1.8	1.9	545	218	15764	366
Kya/Sill	1.4	1.9	447	167	9731	2
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.4	1.5	365	126	8085	23
Silicate	1.7	1.8	481	186	13746	651
Unclassified	1.4	1.4	239	91	6688	237



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Sample Name:	2000769	No. of frames analysed:	42
Lab. Name:	769	No. of particles analysed:	693
Date:	20/07/04	Heavy minerals in raw sand (%):	18.2
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/60x		
Guard region:	275 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	55.4	33.6	0.9	0.3	1.9	1.7	1.8	0.8	0.3	96.8
Leucoxene	69.4	13.4	0.1	0.4	5.7	4.3	1.1	0.4	0.0	94.8
Rutile	93.7	0.3	0.2	0.3	0.8	0.7	0.2	0.4	0.4	97.0
Ti magnetite	36.5	38.1	0.8	0.2	5.3	5.1	2.4	8.2	0.3	96.8
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.5	13.6	0.8	0.1	46.3	23.0	6.6	6.4	0.3	97.6
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	2.4	9.5	0.1	0.3	24.3	53.6	1.7	2.6	0.0	94.4
Zircon	0.1	0.6	0.2	0.1	29.3	0.2	0.1	0.2	63.8	94.6
Silicate	0.8	9.1	0.4	0.1	53.1	13.6	11.5	7.2	0.3	96.1
Unclassified	2.3	3.1	0.5	0.3	5.6	11.4	1.9	65.9	0.9	91.9

Category	Valuable heavy minerals							Total
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	
wt %	58.1	1.2	4.3	5.3	28.5	2.6	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	57.2	73.2	96.6	37.7
Fe <sub>2</sub> O <sub>3</sub> wt%	34.8	14.1	0.3	39.3
MnO wt%	0.9	0.1	0.2	0.8
Cr <sub>2</sub> O <sub>3</sub> wt%	0.3	0.4	0.3	0.3
SiO <sub>2</sub> wt%	2.0	6.0	0.8	5.4
Al <sub>2</sub> O <sub>3</sub> wt%	1.7	4.6	0.7	5.2
MgO wt%	1.9	1.2	0.2	2.5
CaO wt%	0.9	0.4	0.5	8.5
ZrO <sub>2</sub> wt%	0.3	0.0	0.4	0.3
Total	100.0	100.0	100.0	100.0

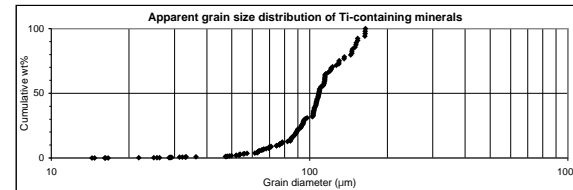
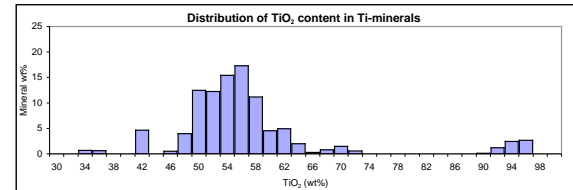
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	20.1	3.6
Leucoxene	0.4	0.1
Rutile	1.5	0.3
Ti magnetite	1.8	0.3
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	9.8	1.8
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.9	0.2
Silicate	43.2	7.8
Unclassified	22.3	4.1
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	58.4
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	55.9
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	769	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	20/07/04		

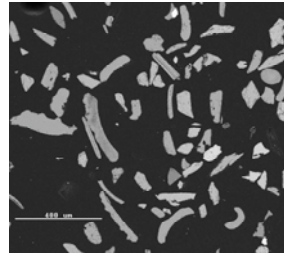


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	367	136	7141	132
Leucoxene	1.4	1.4	280	87	4756	4
Rutile	1.5	1.6	335	125	6304	10
Ti magnetite	1.5	1.7	408	154	9024	9
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.6	1.8	384	150	7120	73
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	1.1	1.0	44	17	159	2
Zircon	1.6	1.6	363	129	6691	6
Silicate	1.7	1.9	473	186	11333	304
Unclassified	1.6	1.6	424	155	11441	153



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Sample Name:	2000771	No. of frames analysed:	42
Lab. Name:	771	No. of particles analysed:	875
Date:	23/07/04	Heavy minerals in raw sand (%):	8.2
Submitter:	Srefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/75x		
Guard region:	275 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	54.6	38.4	1.3	0.1	1.6	1.2	1.0	0.5	0.2	98.9
Leucoxene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rutile	93.7	1.1	0.1	0.1	1.8	0.6	0.3	0.6	0.3	98.5
Ti magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Magnetite	0.8	71.4	0.7	0.2	15.3	5.0	2.6	1.0	0.0	97.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garnet	0.3	20.8	1.1	0.1	42.1	17.6	7.0	8.7	0.2	97.8
Kya/Sill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.4	0.4	0.0	29.0	0.1	0.2	1.4	62.1	93.7
Silicate	1.4	14.0	0.3	0.1	48.4	11.8	9.8	9.1	0.1	95.0
Unclassified	0.6	2.1	0.2	0.2	3.2	2.4	1.2	84.5	0.3	94.7

Category	Valuable heavy minerals							Total	
	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill		Staurolite
wt %	33.1	0.0	12.1	0.0	54.0	0.8	0.0	0.0	100.0

Average content	Normalised average contents of the valuable Ti-containing minerals:			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	55.2	0	95.2	0
Fe <sub>2</sub> O <sub>3</sub> wt%	38.9	0	1.1	0
MnO wt%	1.3	0	0.1	0
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0	0.1	0
SiO <sub>2</sub> wt%	1.7	0	1.8	0
Al <sub>2</sub> O <sub>3</sub> wt%	1.2	0	0.6	0
MgO wt%	1.0	0	0.3	0
CaO wt%	0.5	0	0.6	0
ZrO <sub>2</sub> wt%	0.2	0	0.3	0
Total	100.0	0	100.0	0

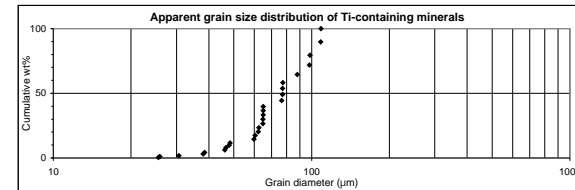
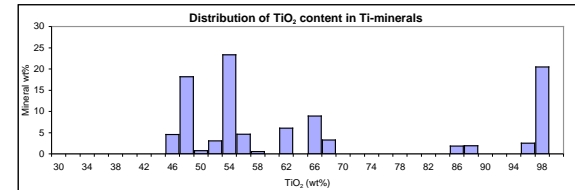
Category	Weight percent on a mineral basis:	
	Heavy mineral concentrate	Raw sand
Ilmenite	3.3	0.3
Leucoxene	0.0	0.0
Rutile	1.2	0.1
Ti magnetite	0.0	0.0
Magnetite	0.5	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	5.4	0.4
Kya/Sill	0.0	0.0
Staurolite	0.0	0.0
Zircon	0.1	0.0
Silicate	36.8	3.0
Unclassified	52.7	4.3
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	65.9
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	55.2
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	771	Analyzed by:	JK
Submitter:	Srefan Bernstein	Acc. Voltage:	17kV
Date:	23/07/04		

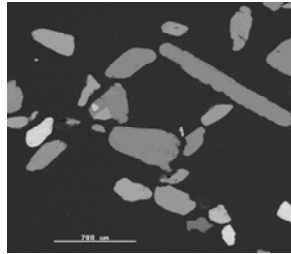


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.6	1.7	261	97	3510	21
Leucoxene	0.0	0.0	0	0	0	0
Rutile	1.6	1.8	281	111	4034	6
Ti magnetite	0.0	0.0	0	0	0	0
Magnetite	3.5	2.7	325	141	3346	3
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	0.0	0.0	0	0	0	0
Garnet	1.8	2.2	303	126	3873	35
Kya/Sill	0.0	0.0	0	0	0	0
Staurolite	0.0	0.0	0	0	0	0
Zircon	2.1	1.7	135	52	900	2
Silicate	2.2	2.2	279	113	3351	416
Unclassified	2.6	3.0	406	176	4994	392



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Sample Name:	2000773	No. of frames analysed:	64
Lab. Name:	773	No. of particles analysed:	637
Date:	23/07/04	Heavy minerals in raw sand (%):	17.9
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	500 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	51.3	42.8	0.7	0.1	1.2	0.8	0.7	0.2	0.2	98.7
Leucoxene	77.5	16.3	0.3	0.3	1.3	1.5	0.9	0.4	0.2	98.6
Rutile	92.2	4.2	0.1	0.2	1.5	0.6	0.0	0.1	0.0	98.9
Ti magnetite	42.0	50.1	0.8	0.1	2.3	1.4	1.0	1.0	0.0	98.7
Magnetite	0.3	95.8	0.0	0.0	0.6	1.6	0.0	0.1	0.4	98.9
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	35.2	1.1	0.4	0.0	31.2	3.0	0.2	27.7	0.0	98.7
Garnet	0.2	25.7	1.5	0.1	40.3	19.8	6.5	4.3	0.1	98.6
Kya/Sill	0.0	0.9	0.2	0.3	43.2	53.2	0.0	0.3	0.3	98.4
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.4	0.1	0.1	29.3	0.0	0.1	0.3	63.9	94.2
Silicate	1.2	14.2	0.3	0.1	46.7	11.4	9.9	12.5	0.1	96.5
Unclassified	1.3	2.7	0.3	0.2	3.3	1.5	1.4	81.2	0.8	92.7

Valuable heavy minerals									
Category	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	Staurolite	Total
wt %	7.2	2.3	0.5	2.1	86.8	0.8	0.3	0.0	100.0

Normalised average contents of the valuable Ti-containing minerals:				
Average content	Category			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	52.0	78.6	93.2	42.5
Fe <sub>2</sub> O <sub>3</sub> wt%	43.3	16.5	4.2	50.8
MnO wt%	0.8	0.3	0.1	0.8
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.3	0.2	0.1
SiO <sub>2</sub> wt%	1.2	1.3	1.5	2.3
Al <sub>2</sub> O <sub>3</sub> wt%	0.9	1.5	0.6	1.4
MgO wt%	0.7	0.9	0.0	1.0
CaO wt%	0.7	0.4	0.1	1.1
ZrO <sub>2</sub> wt%	0.2	0.2	0.0	0.0
Total	100.0	100.0	100.0	100.0

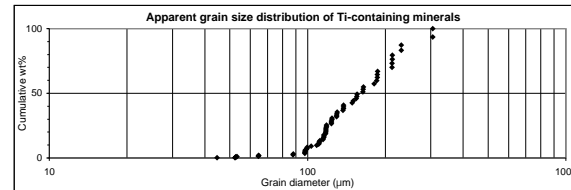
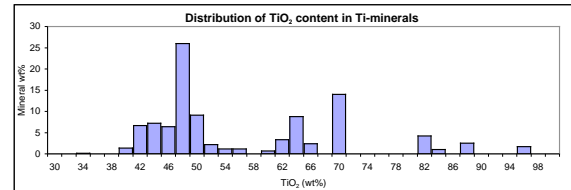
Weight percent on a mineral basis:		
Category	Heavy mineral concentrate	
	wt %	Raw sand wt %
Ilmenite	3.9	0.7
Leucoxene	1.2	0.2
Rutile	0.3	0.0
Ti magnetite	1.1	0.2
Magnetite	0.3	0.1
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	46.5	8.3
Kya/Sill	0.2	0.0
Staurolite	0.0	0.0
Zircon	0.4	0.1
Silicate	22.5	4.0
Unclassified	23.6	4.2
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	57.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	55.7
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	773	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	23/07/04		

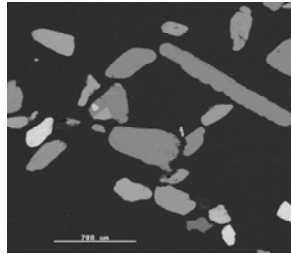


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.8	1.7	496	186	12811	53
Leucoxene	1.8	2.1	775	315	27501	8
Rutile	1.3	1.6	663	243	21583	2
Ti magnetite	1.6	1.6	610	221	20374	9
Magnetite	1.4	1.5	904	307	44448	1
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	2.1	2.2	325	133	3880	1
Garnet	1.8	2.1	930	377	41722	221
Kya/Sill	1.6	2.1	739	299	21122	2
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.3	1.4	413	135	9908	7
Silicate	1.7	1.8	691	263	27985	241
Unclassified	2.0	2.2	1313	533	75309	92



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Sample Name:	2000773	No. of frames analysed:	64
Lab. Name:	773	No. of particles analysed:	637
Date:	23/07/04	Heavy minerals in raw sand (%):	17.9
Submitter:	Stefan Bernstein	Comments:	
Country:	Madagascar		
Analyzed by:	JK		
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	500 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	51.3	42.8	0.7	0.1	1.2	0.8	0.7	0.2	0.2	98.7
Leucoxene	77.5	16.3	0.3	0.3	1.3	1.5	0.9	0.4	0.2	98.6
Rutile	92.2	4.2	0.1	0.2	1.5	0.6	0.0	0.1	0.0	98.9
Ti magnetite	42.0	50.1	0.8	0.1	2.3	1.4	1.0	1.0	0.0	98.7
Magnetite	0.3	95.8	0.0	0.0	0.6	1.6	0.0	0.1	0.4	98.9
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	35.2	1.1	0.4	0.0	31.2	3.0	0.2	27.7	0.0	98.7
Garnet	0.2	25.7	1.5	0.1	40.3	19.8	6.5	4.3	0.1	98.6
Kya/Sill	0.0	0.9	0.2	0.3	43.2	53.2	0.0	0.3	0.3	98.4
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.1	0.4	0.1	0.1	29.3	0.0	0.1	0.3	63.9	94.2
Silicate	1.2	14.2	0.3	0.1	46.7	11.4	9.9	12.5	0.1	96.5
Unclassified	1.3	2.7	0.3	0.2	3.3	1.5	1.4	81.2	0.8	92.7

Valuable heavy minerals									
Category	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	Staurolite	Total
wt %	7.2	2.3	0.5	2.1	86.8	0.8	0.3	0.0	100.0

Normalised average contents of the valuable Ti-containing minerals:				
Average content	Category			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	52.0	78.6	93.2	42.5
Fe <sub>2</sub> O <sub>3</sub> wt%	43.3	16.5	4.2	50.8
MnO wt%	0.8	0.3	0.1	0.8
Cr <sub>2</sub> O <sub>3</sub> wt%	0.1	0.3	0.2	0.1
SiO <sub>2</sub> wt%	1.2	1.3	1.5	2.3
Al <sub>2</sub> O <sub>3</sub> wt%	0.9	1.5	0.6	1.4
MgO wt%	0.7	0.9	0.0	1.0
CaO wt%	0.7	0.4	0.1	1.1
ZrO <sub>2</sub> wt%	0.2	0.2	0.0	0.0
Total	100.0	100.0	100.0	100.0

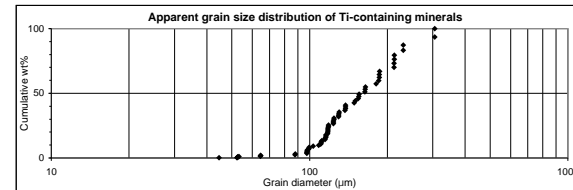
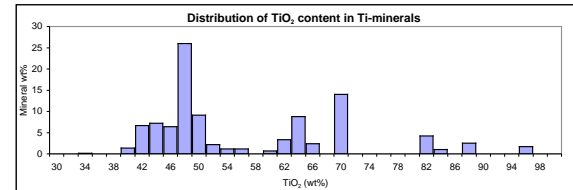
Weight percent on a mineral basis:		
Category	Heavy mineral concentrate	
	wt %	Raw sand wt %
Ilmenite	3.9	0.7
Leucoxene	1.2	0.2
Rutile	0.3	0.0
Ti magnetite	1.1	0.2
Magnetite	0.3	0.1
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.0	0.0
Garnet	46.5	8.3
Kya/Sill	0.2	0.0
Staurolite	0.0	0.0
Zircon	0.4	0.1
Silicate	22.5	4.0
Unclassified	23.6	4.2
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	57.3
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	55.7
Valuable heavy minerals in raw sand:	0.00

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Lab. Name:	773	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	23/07/04		

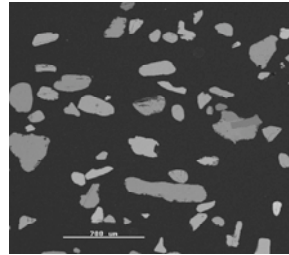


Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.8	1.7	496	186	12811	53
Leucoxene	1.8	2.1	775	315	27501	8
Rutile	1.3	1.6	663	243	21583	2
Ti magnetite	1.6	1.6	610	221	20374	9
Magnetite	1.4	1.5	904	307	44448	1
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	2.1	2.2	325	133	3880	1
Garnet	1.8	2.1	930	377	41722	221
Kya/Sill	1.6	2.1	739	299	21122	2
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.3	1.4	413	135	9908	7
Silicate	1.7	1.8	691	263	27985	241
Unclassified	2.0	2.2	1313	533	75309	92



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Sample Name:	2000777	No. of frames analysed:	38
Lab. Name:	777	No. of particles analysed:	718
Date:	10/08/04	Heavy minerals in raw sand (%):	10.6
Submitter:	Stefan Bernstein	Country:	Madagascar
Analyzed by:	JK	Comments:	
Acc. Voltage/Magnification:	17kV/40x		
Guard region:	500 µm		
Sieve:	100 µm		



Category	Average content									
	TiO <sub>2</sub> wt%	Fe <sub>2</sub> O <sub>3</sub> wt%	MnO wt%	Cr <sub>2</sub> O <sub>3</sub> wt%	SiO <sub>2</sub> wt%	Al <sub>2</sub> O <sub>3</sub> wt%	MgO wt%	CaO wt%	ZrO <sub>2</sub> wt%	Total
Ilmenite	53.7	40.5	0.9	0.1	0.8	0.6	0.7	0.6	0.2	98.0
Leucoxene	71.1	21.9	0.6	0.0	1.2	1.8	0.4	1.3	0.5	98.8
Rutile	93.1	3.8	0.2	0.2	0.6	0.3	0.1	0.5	0.2	98.9
Ti magnetite	42.0	40.2	0.8	0.1	1.2	0.5	1.2	9.9	0.4	96.3
Magnetite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Monazite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y-phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sphene	40.9	3.2	0.0	0.5	0.7	0.6	0.4	52.4	0.0	98.6
Garnet	0.1	24.8	1.4	0.2	39.9	19.8	6.3	5.7	0.1	98.3
Kya/Sill	0.0	1.3	0.1	0.2	42.9	53.4	0.0	0.3	0.2	98.4
Staurolite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zircon	0.3	0.8	0.1	0.2	29.3	1.1	0.1	0.8	61.5	94.2
Silicate	1.3	13.1	0.3	0.2	47.6	11.6	9.9	11.7	0.1	95.8
Unclassified	0.3	1.7	0.2	0.3	2.8	1.7	1.1	86.7	0.3	95.0

Valuable heavy minerals									
Category	Ilmenite	Leucoxene	Rutile	Ti magnetite	Garnet	Zircon	Kya/Sill	Staurolite	Total
wt %	5.7	0.6	1.9	2.2	87.6	1.2	0.8	0.0	100.0

Normalised average contents of the valuable Ti-containing minerals:				
Average content	Category			
	Ilmenite	Leucoxene	Rutile	Ti magnetite
TiO <sub>2</sub> wt%	54.8	72.0	94.1	43.6
Fe <sub>2</sub> O <sub>3</sub> wt%	41.3	22.1	3.8	41.7
MnO wt%	0.9	0.6	0.2	0.8
Cr <sub>2</sub> O <sub>3</sub> wt%	0.2	0.0	0.2	0.1
SiO <sub>2</sub> wt%	0.8	1.2	0.6	1.2
Al <sub>2</sub> O <sub>3</sub> wt%	0.6	1.9	0.3	0.5
MgO wt%	0.7	0.4	0.1	1.2
CaO wt%	0.7	1.3	0.5	10.3
ZrO <sub>2</sub> wt%	0.2	0.6	0.2	0.4
Total	100.0	100.0	100.0	100.0

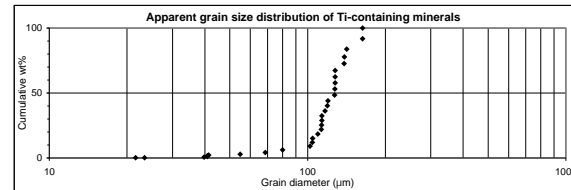
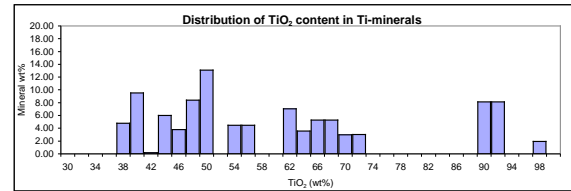
Weight percent on a mineral basis:		
Category	Heavy mineral concentrate	
	wt %	Raw sand wt %
Ilmenite	1.8	0.2
Leucoxene	0.2	0.0
Rutile	0.6	0.1
Ti magnetite	0.7	0.1
Magnetite	0.0	0.0
Chromite	0.0	0.0
Pyrite	0.0	0.0
Phosphate	0.0	0.0
Monazite	0.0	0.0
Y-phosphate	0.0	0.0
Sphene	0.2	0.0
Garnet	27.2	2.9
Kya/Sill	0.3	0.0
Staurolite	0.0	0.0
Zircon	0.4	0.0
Silicate	37.3	3.9
Unclassified	31.5	3.3
Total	100.0	

Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals:	60.6
Average TiO <sub>2</sub> content of all the TiO <sub>2</sub> minerals excl. rutile:	53.2
Valuable heavy minerals in raw sand:	0.00

Geological Survey of Denmark and Greenland  
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Lab. Name:	777	Analyzed by:	JK
Submitter:	Stefan Bernstein	Acc. Voltage:	17kV
Date:	10/08/04		



Category	Average grain parameters					Total grains
	Aspect ratio	Circularity	Perimeter (µm)	Length (µm)	Area (µm <sup>2</sup> )	
Ilmenite	1.5	1.5	383	130	8717	18
Leucoxene	1.7	1.4	388	125	8582	2
Rutile	1.6	1.9	605	245	15649	3
Ti magnetite	1.3	1.2	311	94	8063	7
Magnetite	0.0	0.0	0	0	0	0
Chromite	0.0	0.0	0	0	0	0
Pyrite	0.0	0.0	0	0	0	0
Phosphate	0.0	0.0	0	0	0	0
Monazite	0.0	0.0	0	0	0	0
Y-phosphate	0.0	0.0	0	0	0	0
Sphene	1.7	1.7	607	224	17726	1
Garnet	1.8	1.8	491	190	12020	227
Kya/Sill	1.4	2.0	612	240	16232	2
Staurolite	0.0	0.0	0	0	0	0
Zircon	1.6	1.5	314	109	5461	6
Silicate	1.7	1.7	565	212	16789	336
Unclassified	1.7	1.9	873	345	40373	116