Mineralogical Report

Heavy Mineral Sands

Investigation of Ti distribution

Example Report (selected pages)

Report to:

Client Name plc

By:

Petrolab Limited www.petrolab.co.uk

Tel +44 (0)1209 219541 **email** petrolab@petrolab.co.uk

C Edwards Offices, Gweal Pawl, Redruth, Cornwall TR15 3AE

Project Mineralogist

James Strongman MSci ARSM

For & on behalf of Petrolab Limited

Registered in England & Wales -- Company No. 4777735

Contents

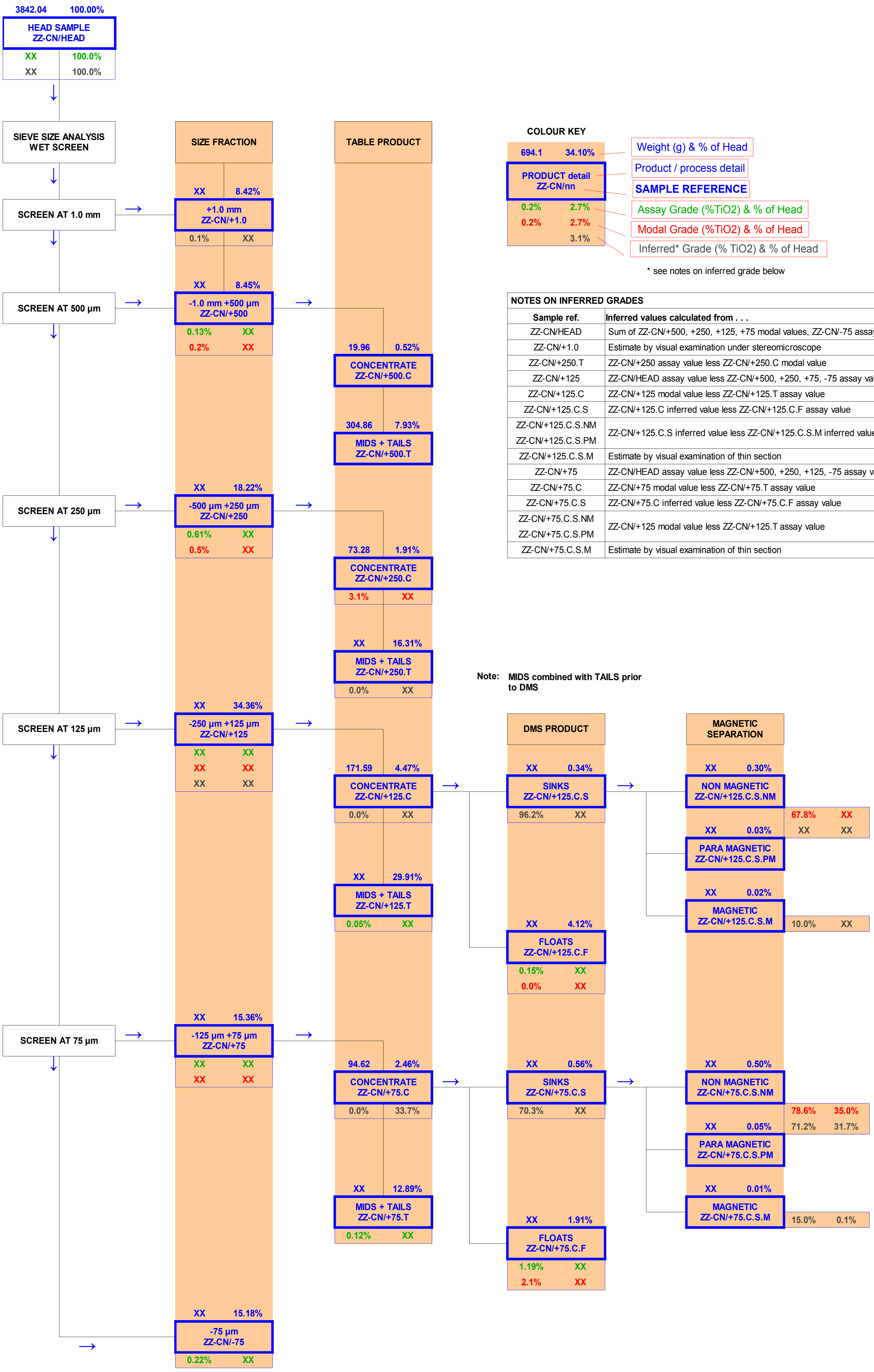
Index of Tables

MINERALOGICAL REPORT

Client:	***Client Name plc***
Sample source:	***Heavy Mineral Sands***
Sample type:	***Stream sediment samples***
Analysis required:	***Investigation of Ti distribution***
Client reference:	***ABC01***
Report date:	***Example Report (selected pages)***
Report version:	

Executive summary (Ti distribution)

1. Two stream sediment samples were received and combined for a mineralogical investigation of titaniferous phases.
2. The TiO_2 assay grade determind by XRF analysis for the combined head sample (ref. ZZ-CN/HEAD) was X.XX%.
3. A flowsheet was developed for the mineral processing testwork – *see Figure 1 overpage*. The primary objective of the investigation was to determine the amount and distribution of titaniferous minerals in the combined sample. It was reported that previous testwork on split samples had produced anomalous results.
4. The head sample was wet screened to produce +1.0 mm, +500 µm, +250 µm, +125 µm, +75 µm and -75 µm fractions.
5. The TiO_2 assay grades of the fractions infer a head grade of X.XX%.
6. The TiO_2 head grade estimated from modal analyses of the fractions is X.XX%.
7. Between XX% to XX% of the TiO_2 in the head sample reported to the +125 µm and +75 µm fractions. A detailed particle size distribution analysis of titaniferous phases in the +250 µm fraction (ZZ-CN/+250.C) suggests that increasing the top size of the +125 µm fraction to 300 µm would moderately improve recovery of TiO_2 without excessively increasing the feed mass (see Appendix 3).
8. Only 2% of the the head TiO_2 was lost to the fine (-75 µm) fraction (XRF assay data).
9. Benefication testwork was undertaken on the +125 µm and +75 µm fractions. Gravity separation using a Mozley Table followed by treatment of the concentrate with a heavy liquid was used to upgrade the two selected size fractions. The sinks recovered 94% of the TiO_2 from the 125 µm fraction (approximately XX% of the TiO_2 in the head sample); from the +75 µm fraction the sinks recovered 91% of the TiO_2 (approximately XX% of the TiO_2 in the head sample).
10. TiO_2 reporting to the mids, tailings and floats products are all attributed to processing losses. There was no significant evidence of locking, intergrowths or other mineral associations contributing to TiO_2 losses.
11. Titanium bearing phases identified are rutile, pseudorutile, ±ilmenite. All are highly liberated (>95%). TiO_2 is present predominately in the form of rutile / pseudorutile, with only trace or minor amounts present in ilmenite.
12. Figure 1 (overpage) shows summary mass flow and TiO_2 data for all fractions and testwork products investigated.



NOTES ON INFERRED GRADES

Sample ref.	Inferred values calculated from . . .
ZZ-CN/HEAD	Sum of ZZ-CN/+500, +250, +125, +75 modal values, ZZ-CN/-75 assay value and inferred ZZ-CN/+1.0 value
ZZ-CN/+1.0	Estimate by visual examination under stereomicroscope
ZZ-CN/+250.T	ZZ-CN/+250 assay value less ZZ-CN/+250.C modal value
ZZ-CN/+125	ZZ-CN/HEAD assay value less ZZ-CN/+500, +250, +75, -75 assay values and inferred ZZ-CN/+1.0 value
ZZ-CN/+125.C	ZZ-CN/+125 modal value less ZZ-CN/+125.T assay value
ZZ-CN/+125.C.S	ZZ-CN/+125.C inferred value less ZZ-CN/+125.C.F assay value
ZZ-CN/+125.C.S.NM ZZ-CN/+125.C.S.PM	ZZ-CN/+125.C.S inferred value less ZZ-CN/+125.C.S.M inferred value (>100% maximum theoretical grade)
ZZ-CN/+125.C.S.M	Estimate by visual examination of thin section
ZZ-CN/+75	ZZ-CN/HEAD assay value less ZZ-CN/+500, +250, +125, -75 assay values and inferred ZZ-CN/+1.0 value
ZZ-CN/+75.C	ZZ-CN/+75 modal value less ZZ-CN/+75.T assay value
ZZ-CN/+75.C.S	ZZ-CN/+75.C inferred value less ZZ-CN/+75.C.F assay value
ZZ-CN/+75.C.S.NM ZZ-CN/+75.C.S.PM	ZZ-CN/+125 modal value less ZZ-CN/+125.T assay value
ZZ-CN/+75.C.S.M	Estimate by visual examination of thin section

Figure 1: Mass flowsheet ***(some figures removed from original report to maintain confidentiality)***

4.3 Particle size distribution

The particle size distribution (PSD) according to the dry weights of the screened fractions is shown in Table 7 and Figure 2.

Screen size	*Weight*		*Finer*
(µm)	(g)	(%)	(%)
1000	323.3	8.4	91.6
500	324.8	8.5	83.1
250	699.9	18.2	64.9
125	1320.7	34.4	30.5
75	590	15.4	15.2
-75	583.4	15.2	
Total	**3842.1**	**100**	

Table 7 : Screened fractions : PSD by retained weights

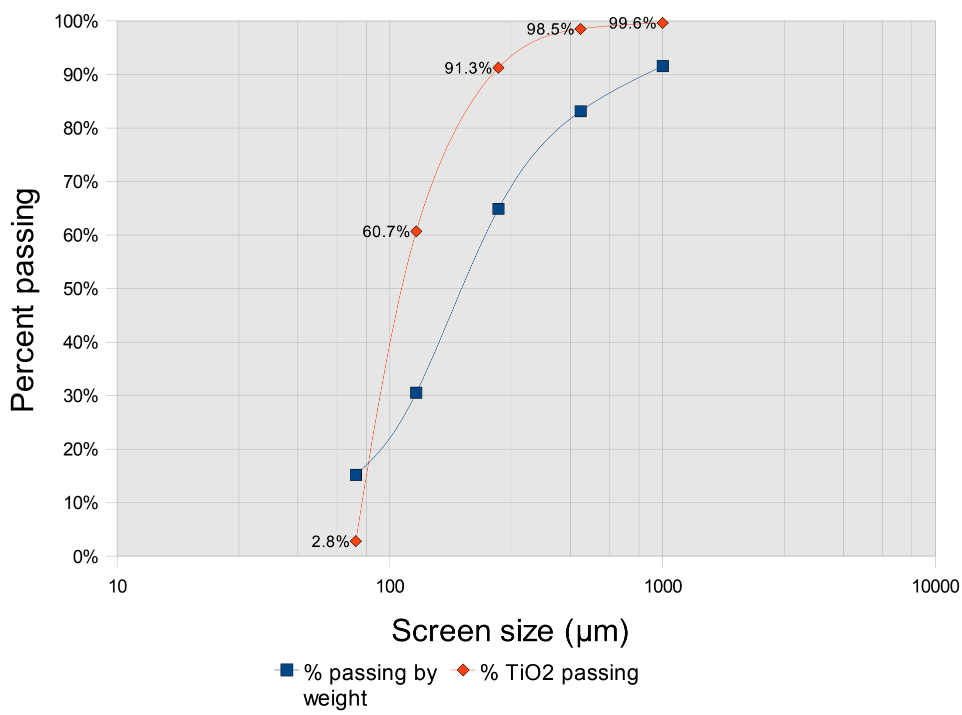


Figure 2 : ZZ-CN/HEAD : PSD by % weight & estimated % TiO_2 distribution

5.3 Sample ref: ZZ-CN/+250.C

5.3.1 Modal analysis

Mineral	Formula	Av s.g.	Wt%
Quartz	SiO_2	2.65	86.1%
Kyanite	Al_2SiO_5	3.61	9.5%
Rutile	**TiO_2**	**4.25**	**2.9%**
Garnet (Grossular)	Ca3Al2(SiO4)3	3.57	0.4%
Ilmenite	**$FeTiO_3$**	**4.72**	**0.3%**
Zircon/Monazite	$ZrSiO_4$ / (Ce,La,Nd,Pr)PO_4	4.65/5.2	0.3%
Tourmaline (Schorl)	$NaFe_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	3.15	0.2%
Kaolinite	Al2Si2O5(OH)4	2.60	0.1%

Table 24 : ZZ-CN/+250.C : Modal analysis data

5.3.2 Liberation

Mineral locked	Quartz	Ilmenite-Rutile	Kyanite	Zircon/ Monazite	%locked	%liberated
Quartz	-	none	none	none	<5%	>95%
Ilmenite - Rutile	none	-	trace	none	<5%	>95%
Kyanite	none	trace	-	trace	<5%	>95%
Zircon/Monazite	none	none	50%	-	50%	50%

Table 25 : ZZ-CN/+250.C : Liberation study

5.3.3 Locking characteristics

Mineral	Min	Max	Av	Prominent type
Ilmenite - Rutile	100 µm	700 µm	350 µm	Liberated grains
Description	Liberated grains and rare as simple inclusions in kyanite.			
Quartz	200 µm	600 µm	400 µm	Liberated grains
Description	Liberated irregular single crystal fragments. Grains host rare simple inclusions of rutile. Quartz grains show rare iron oxide stains.			
Kyanite	250 µm	600 µm	450 µm	Liberated grains
Description	Liberated single crystal fragments, it also contains rare simple inclusions of rutile (80 µm – 120 µm) and zircon (40 µm – 90 µm).			
Tourmaline	40 µm	500 µm	350 µm	Liberated grains
Description	Liberated grains and rare euhedral inclusions in quartz.			

Table 26 : ZZ-CN/+250.C : Locking

7.5 Sample ref: ZZ-CN/+75.C.S.NM & ZZ-CN/+75.C.S.PM

Mineral	*Formula*	*Av s.g.*	*Wt%*
Rutile	**TiO_2**	**4.25**	**75.7%**
Kyanite	Al_2SiO_5	3.61	10.4%
Zircon/Monazite	$ZrSiO_4$ / (Ce,La,Nd,Pr)PO_4	4.65 / 5.2	8.1%
Ilmenite	**$FeTiO_3$**	**4.72**	**5.6%**
Tourmaline (Schorl)	$NaFe_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$	3.15	0.1%
Garnet (Grossular)	Ca3Al2(SiO4)3	3.57	Trace
Quartz	SiO2	2.65	0.0%

Table 44 : ZZ-CN/+75.C.S.NM & ZZ-CN/+75.C.S.PM : Modal analysis data

7.5.1 Liberation

Mineral locked	*Ilmenite-Rutile*	*Kyanite*	*Zircon/ Monazite*	*%locked*	*%liberated*
Ilmenite - Rutile	-	trace	none	<5%	>95%
Kyanite	trace	-	none	<5%	>95%
Zircon/Monazite	none	none	-	<5%	>95%

Table 45 : ZZ-CN/+75.C.S.NM & ZZ-CN/+75.C.S.PM : Liberation study

7.5.2 Locking characteristics

Mineral	*Min*	*Max*	*Av*	*Prominent type*
Ilmenite - Rutile	40µm	180µm	130 µm	Liberated grains
Description	Liberated single crystals, angular to rounded, typically subrounded			
Kyanite	70µm	180µm	120 µm	Liberated grains
Description	Liberated single crystal fragments. Kyanite also hosts extremely rare simple inculsions of rutile			
Zircon/Monazite	80µm	200µm	120µm	Liberated grains
Description	Rounded liberated grains. Some of the material identified as zircon was identified on the stereomicroscope as monazite.			

Table 46 : ZZ-CN/+75.C.S.NM & ZZ-CN/+75.C.S.PM : Locking

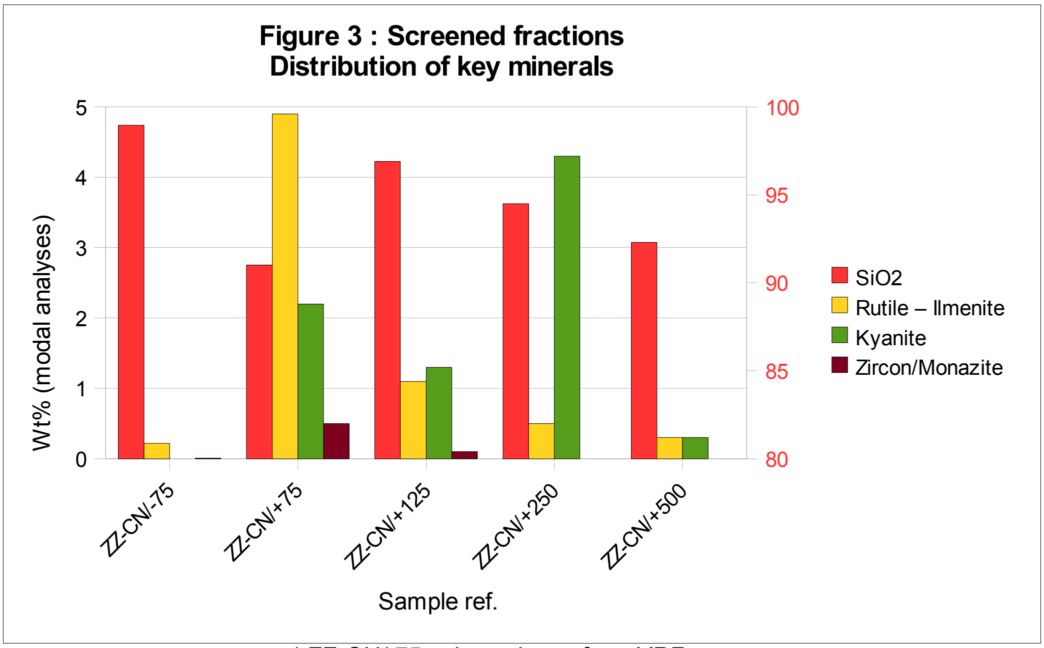
7.6 Sample ref: ZZ-CN/+75.C.S.M

Mineral	*Formula*	*Av s.g.*	*Abundance*
Limonite/Hematite	$Fe^{3+}O(OH)$ / Fe_2O_3	3.8 / 5.3	Major
Ilmenite	**$FeTiO_3$**	**4.7**	**Major**
Rutile	**TiO_2**	**2.6**	**Trace**
Zircon/Monazite	$ZrSiO_4$ / $(Ce,La,Nd,Pr)PO_4$	4.6	Trace
Kyanite	Al_2SiO_5	3.61	Trace

Table 47 : ZZ-CN/+75.C.S.M : Mineral identification

8 Mineralogical summary

- TiO_2 is present predominately in the form of rutile and pseudorutile, ± traces of ilmenite.
- Rutile is extremely well liberated (>95%) in all fractions and test products investigated.
- Rutile shows significant variations in colour indicating a wide variety of compositions from ilmenite/pseudorutile to rutile.
- The majority of rutile / pseudorutile grains show a slight purple colouration indicating that they probably contain some iron. SEM analysis would be required to determine the compositional range of the ilmenite, pseudorutile and rutile.
- Other than the titaniferous phases, all fractions and test products investigated also contain significant amounts of kyanite. Kyanite is generally extremely well liberated but exhibits rare inclusions of rutile and zircon.
- Zircon is present in significant amounts in the investigated +250 µm and finer fractions. Some of the zircon was identified under the stereomicroscope as monazite. SEM analysis would be required to determine the distribution between zircon and monazite. Both zircon and monazite are extremey well liberated.
- Both kyanite and zircon have similar specific gravities to the TiO_2 bearing minerals and were effectively upgraded with the TiO_2 minerals.
- The principle gangue mineral is quartz. It is extremely well liberated, devoid of inclusions and may be suitable as a high quality silica sand product.



** ZZ-CN/-75 values shown from XRF assay*