

MAR 19570002: MARASEK'S BURMIS

Received date: Dec 31, 1957

Public release date: Jan 01, 1959

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INTERPRETATION OF LOGARITHMIC CURVES OF METALLURGICAL
RELATIONSHIPS OF Fe, Ti, Insoluble and L.O.I. FE-AF-009(08)
BY ROBERT STEINER

"Narasek's" January, 1957

1. Data derived from 167 core samples, average length 5.0'.
2. Assays by Lerch Bros. Inc., Steep Rock Lake, Ontario.
3. Assays averaged to give ore grade, (Fe):
 - (a) 0-20%
 - (b) 20-40%
 - (c) 40% or over
4. Sections 3a, 3b, 3c were broken into
 - (a) Fe:Ti
 - (b) Fe: Insol.
 - (c) Fe: L.O.I.
 - (d) Ti: Insol.
 - (e) Ti: L.O.I.

5. The mean averages were:

	Fe	Fe%	Ti%	Insol%	L.O.I.%	No. of Samples
0-20%		13.67	2.83	47.43	12.27	46
20-40%		29.03	5.76	29.31	10.18	84
40+		45.69	7.37	16.32	7.05	37

6. The averages of (5) were plotted logarithmically and the following observations made:
 - (a) The Ti content varies directly as the Fe content; e.g. as the grade of iron increases, so does the titanium.
 - (b) The Insolubles vary inversely as the iron; e.g. as the grade of iron increases the insolubles decrease.
 - (c) The loss on Ignition varies inversely as the iron content; e.g. as the grade of iron increases the L.O.I. decreases
 - (d) The insolubles vary inversely as the titanium contents; e.g. as the titanium content increases the insolubles decrease
 - (e) The L.O.I. varies inversely as the titanium content; e.g. as the titanium content increases the L.O.I. decreases.

700626

700641

700654

700667

(2)

Conclusions:

The methods of analysis are not known to the observer. However some procedures are standard. Thus, to get the Fe, the sample is dissolved in a suitable solvent and measured by some type of quantitative analysis. This may or may not also apply to the Ti. The insolubles are probably those parts of the sample, which, for practical purposes, are not affected by the common solvents, or are inert to any usual chemical method of decomposition. The loss on ignition represents that part of the sample which literally goes up in smoke, i.e. becomes a gas or vapour at specific temperatures.

In the normal assay the solubles would be dissolved selectively, then the iron would be dissolved. The residue would then be heated, and the remnant would then constitute the insoluble. There would be variations in the procedure to determine such characteristics as which part of the sample could be retrieved or driven off by heating; which could only be dissolved; and which part would have to be separated mechanically.

As an example, the magnetite could be heated, to drive off the oxygen, and the resultant iron would then be either weighed as such, or dissolved in a solvent acting only on iron. If there was some foreign material with the magnetite it would be taken out next. The most common material could be silica, as quartz. To heat the quartz to the point where the oxygen would be driven off would be impractical, since the iron would melt long before this point was reached. Quartz is also insoluble in nearly all solvents. Thus, after the magnetite was roasted, to drive off the oxygen, the quartz would remain as a residue, and removed after the iron was either dissolved, or removed magnetically. And so on. The above is only a hypothetical example. Now consider the following information.

- Dana:-
- (1) Ilmenite: fusible with bisulfate of sodium or potassium; soluble in H Cl.
 - (2) Titanite: Fusibility of 3 (very low): Imperfectly soluble in H Cl: completely soluble in sulfuric or hydrofluoric acid.
 - (3) Rutile: Infusible: insoluble in acids; soluble by fusion with alkali (Ca, Mn) carbonates.

Now compare the above to the graph: (d) suggests that the titanium is soluble, if H Cl, H₂ SO₄ or HF were used. The titanium could either be ilmenite or titanite. It is certain that in part analyses only H Cl was used. This indicates ilmenite. (e) suggests that the titanium is lost (driven off) on ignition. The titanium could be either ilmenite or rutile. It is known that the next most important constituents are the alkali minerals CaO and MgO. This indicates that if rutile were present, it would burn off with the alkalis. The assay by the Department of Mines and Technical Surveys, Ottawa, October 12, 1956, mentions a high iron content in the tailings. This seems to imply that some of the iron in the tailings may be due to ilmenite, Fe Ti O₃, or rutile with iron.

If solubility means self-soluble, e.g. melts, then rutile is most certainly present. If solubility means action through a solvent then ilmenite is indicated. Thus far petrological examination has shown only ilmenite. Only further tests will prove which of the titanium minerals is most prevalent.

However the case may be, the curves show that the titanium appears to be easily separated from the iron, either as a "smoke" or as a solution. It is expected that the major separation of iron from the other constituents in the ore will be by magnetic means. Thus, although solubility increases with increase in grade, since magnetite is soluble in H Cl, the separation of iron from titanium should not be difficult, since it is assumed that H Cl will not be used in winning the iron from the ore.

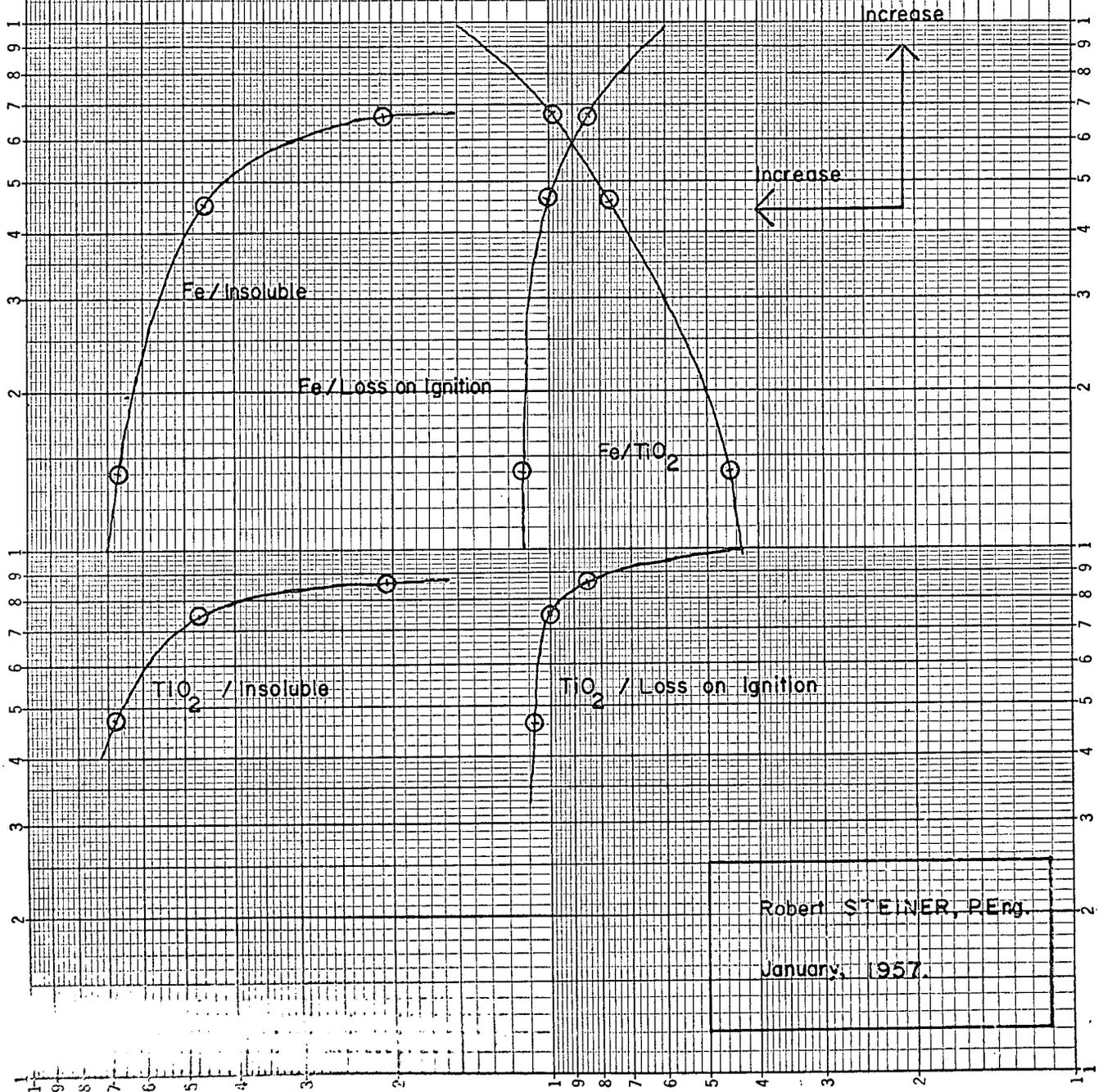
A low loss on ignition can be expected with the higher grade ore. This suggests that if iron is lost on a high loss on ignition, it cannot be magnetite. The Survey suggests that iron could be in the form of carbonates. These would certainly be burned off. If this is the case, then a precipitator would have to be employed to retrieve the iron from the smoke, (fumes).

As mentioned above, curve (b) indicates a progressively higher solubility as the Fe content increases. If solubility means soluble iron, then the higher the grade, the more soluble it is. But it also implies that the higher the grade of ore, the lower the amount of such foreign constituents as quartz and feldspar. Referring again to the Surveys Report, decreasing solubility indicates less iron, and this suggests that either there is little iron at this end of the curve, or the iron is insoluble. Siderite therefore cannot be in quantity in this ore, since if it were, it would be quite soluble. And the iron mentioned by the Surveys must be some other type of iron mineral. These may be non-magnetic iron oxides, such as some varieties of hematite or limonite.

It is interesting to note that the iron: insoluble and L.O.I. appear to be similar to titanium: insoluble and L.O.I. curves. Such a unique parallelism should be an aid in the successful solution to metallurgical problems which may be encountered in the future.

INTERPRETATION OF LOGARITHMIC CURVES OF
METALLURGICAL RELATIONSHIPS OF
Fe, Ti, Insoluble and Loss on Ignition

M A R A S E K S



Robert STEINER, PE, Eng.

January, 1957.

STRIPPING ESTIMATES

The strip ratio for this area must be calculated on the basis of the following information:

- (1) There are three ore horizons (the result of faulting.)
- (2) Due to topography and structural deformation the two highest horizons (elevation wise) have comparatively little overburden.
- (3) The number 3 horizon (lowest) will be considered to be overlain by a total overburden minus that are contained in No. 1 and No. 2 horizons.
- (4) The overburden will therefore be calculated from the highest elevation to the top of No. 3 horizon.
- (5) Calculations are based on type area : Marasek Section 112 + 00, over an area of 600,000 sq ft.

$$\text{Area} = 600,000 \text{ ft.}^2$$

Average depth of overburden to top of No. 3 (lowest elevation) horizon is 91.

This interval of overburden is further reduced by a total of 26' of ore (No. 1 and 2 horizons). Therefore the net thickness of overburden is

$$91 - 26 = 65'$$

Therefore the volume of overburden over the type area is

$$\frac{600,000 \times 65}{27} = 1,440,000 \text{ cu. yds.}$$

The tonnage of ore contained is $\frac{600,000 \times 3 \times 13}{10} = 2,340,000$ tons.

The ratio thus becomes $\frac{1.44 \times 10^6}{2.34 \times 10^6} = 0.61$ cu. yds. per ton.

The the type area Marasek Section 112+00 be applied to the presently outlined ore limits, the ratio for the recovery of the proven tonnage of 6.68×10^5 short tons should not vary significantly from the figure of 0.61 derived above.

ORE CALCULATIONS FOR THE "MARASEKS"

These estimates are subject to further revision as additional information is accumulated.

Calculations are based on the formula $T = \frac{A \times D}{V}$

where T - short tons

A - area

D - depth or thickness (See PEELE)

V - volumetric weight (HANDBOOK OF MINING ENG.)

Using Section 112 + 00 as the type - section and assuming that this holds true for all other sections drilled, the following takes place.

- (1) Number of horizons = 3 to 6
 - (2) Number of fault sets = 3
 - a) dip 40 deg. east, trending northerly
 - b) dip 60 deg. west, " "
 - c) dip 10 deg. east " southerly
- Order of faulting is a) to c)

a) (1) displacement is 18 feet vertically and 28 feet horizontally.

b) (1) displacement is 26 feet vertically and 13 feet horizontally.

c) (1) displacement is 6 feet vertically and 140 feet horizontally.

This displacement applies for 100 feet horizontally for all three fault sets. Probable length of ore horizons is 248 feet per 142 feet dip - strike distance on fault - set (c)

- (3) Limits of ore disposition
 - a) North-south 6,000 feet
 - b) East-West 1,500 feet

Area enclosed = $6,000 \times 1,500$
 = 9×10^6 sq. ft.

less barren area (e.g. erosional features)

$400' \times 2,000 = 0.8 \times 10^6$
 $= 1,500 \times 700 = \frac{1.05 \times 10^6}{1.05} \text{ sq. ft.}$

Total 1.85×10^6

Total potential producing area = 9.0×10^6 minus 1.85×10^6
 = 7.15×10^6 sq. ft.

- Continued

(2)

Continued - ORE CALCULATIONS FOR THE "MARASEKS"

(4) Average thickness of ore as per logs.

a)	b)	c)
6	2	56
23	18	3
13	1	6
13	25	9
18	23	
	10	
	6	
	3	
	1	
<u>73</u>	<u>89</u>	<u>74</u>

Averages a) 14.6 b) 9.9 c) 18.5

Total Average = 13.1 feet

Total inferred tonnage as per formula = $T = \frac{A \times D}{V}$

$$T = \frac{7.15 \times 10^6 \times 13.1}{8.8}$$

$$= 10.65 \times 10^6 \text{ short tons}$$

(5) Area drilled = $3,000 \times 1,500$
= 4.5×10^6 sq. ft.

Applying : Section 112 + 00 by $A = \frac{T \times D}{V}$

$$\text{proven tonnage is } \frac{3,000 \times 1,500 \times 13.1}{8.8}$$

$$= 6.68 \times 10^6 \text{ short tons}$$

(6) Inferred tonnage to be expected by further drilling is 10.65 million less 6.68 million = 3.97 million short tons between the limits outlined above.