Proceedings of the International Seminar on Mineral Processing Technology - 2006, Chennai, India. pp. 103 - 111.

Identification of Vanadium on Iron Ore Sample from a Deposit in Choghart Area, Iran from Beneficiation Point of View

B. Rezai[1], A. Pazoki[2] and G.H. Ghorbankarimi[1]

[1] *Department of Mining and Metallurgical Engineering, Amir Kabir University of Technology, Tehran- Iran*
[2] *Eng .Department . Lorestan university.Iran*

Abstract

Large deposits of titanoferous vanadium bearing magnetites have been reported from different parts of Iran including those of Choghart area which are rich in vanadium. These deposits cannot be directly used for the production of vanadium because of the unknown feature and characteristics of vanadium in the deposits. To know the mineralogical composition, shape of the particles, chemical character and mesh of grind which play vial role in flowsheet design, samples from Choghart have been subjected to detailed mineralogical and microscopic studies especially SEM, sieve analysis, liberation studies using Davis tube, sink and float tests and particle counting methods and chemical analysis. The results show that most of vanadium is present in magnetite minerals analysing V2O5 0.45%.Magnetite, hematite, talc (as major minerals) and apatite, calcite, goethite, feldspars, amphibole and pyroxene (as minor minerals) are present in the order of abundance and liberation studies have shown that most of the magnetite particles are free at below 150 microns in which, vanadium element replaced iron, in magnetite structure. This and evenly distribution of vanadium in magnetite sample were further confirmed by SEM technique. Based on the characterization studies carried out it can be predicted, that the combination of low intensity magnetic separation, roasting and leaching would the possible techniques to recover vanadium without ineffective destruction of magnetite structure.

Keywords: *Magnetite, Vanadium, Characterization, Choghart, Iron ore deposits, SEM, Davis tube*

INTRODUCTION

Vanadium with world resources of more than 63 million tons has proved to be an important alloying element in ferrous and non- ferrous alloys and approximately 95% of the world consumption is in this way [1, 2]. The economic sources of vanadium have changed from pattronite, through carnotite over the years and now is limited to shales, clays and vanadiferous titanomagnetite. It was recovered from ash of venzualan oils, lignite and bauxites, however the technology has also undergone suitable modifications to enable the recovery of not only vanadium, but also, of vanadium and iron of all the three- vanadium, iron and titania [3, 4, 5]. Huge deposits of titaniferous magnetite containing appreciable amount of vanadium occur in Choghart, Chadormelu, Zarand, Sechahun, Chahegaz and many other places in Iran [6]. Because of the non-availablity of vanadium deposits in many countries, such type of deposits can be considered for the recovery of vanadium [7, 8]. But the deposits of aforementioned areas especially Choghart has not been so far subjected to characterization studies from vanadium beneficiation point of view, however the detailed beneficiation studies have been

carried out by the authors recently. This paper deals with the characterization studies and the results obtained, are encouraging from the process metallurgical point of view and discussed in an appropriate parts of the paper.

EXPERIMENTAL METHODS

A part of the bulk sample (600 kgs) received was subjected to sampling by techniques such as Jones riffles and coning and quartering, and representative samples were prepared for further studies.

CHEMICAL ANALYSIS

The representative sample was ground to obtain a product of –150 microns and kept in an oven at constant temperature (105 0C) for 5 hours. The results of chemical analysis are given Table 1.

Table 1: Chemical Analysis of Head Sample

Constituents	Weight%
Fe_2O_3	87.79
SiO_2	4.26
CaO	2.15
TiO_2	1.14
V_2O_3	0.45
P_2O_5	0.33
Others	3.87
Total	100

X – RAY DIFFRACTION STUDIES

It is not only used for identification of minerals and their crystalline character but also for assessing the abundance of each mineral phase in a mixture. The representative sample was ground to obtain a product of –74 microns employing a Phillips powder diffraction unit. From the XRD studies and with the help of Table 1, it is possible to know that magnetite is the main mineral present (65%). Other minerals like hematite (25%), talc (5%),calcite(2-3%), apatite (1-2%) and feldspar (1%) are present in order of abundances.

PETROGRAPHIC STUDIES

In beneficiation studies petrographic investigation plays an important role. The thin and polished sections of samples are prepared and subjected to petrographic studies. The modal proportion (average of 20 sections) is given in Table 2. The microphotographs are also illustrated in Fig 1, 2 and 3. However the results of SEM studies for conformation of presence and situation of vanadium, iron and titanium were also shown in Fig 4 and 5.

Table 2: The Modal Analysis of the Constituent Minerals

	Mineral	Modal %	Grain size ~ μ
1	Magnetite	65	20-500
2	Hematite	25	10-100
3	Talc	5	30-100
4	Calcite	3	30-800
5	Apatite	2	50-1000

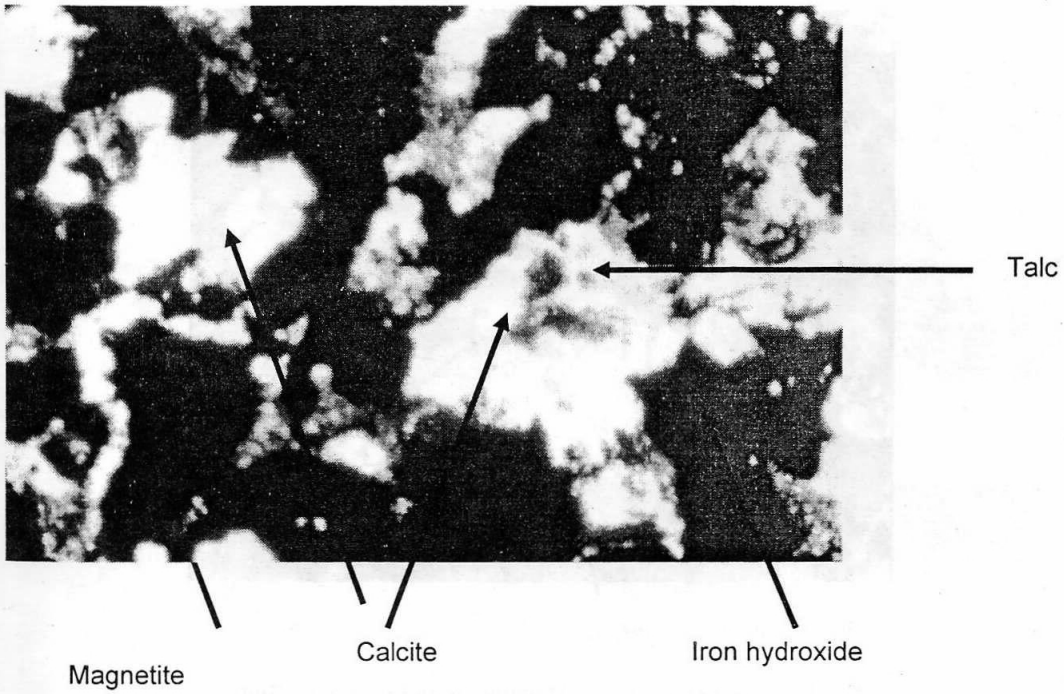

Fig. 1: Micrographs of Talc, Calcite and Iron Hydroxide Along with Magnetite (X40)

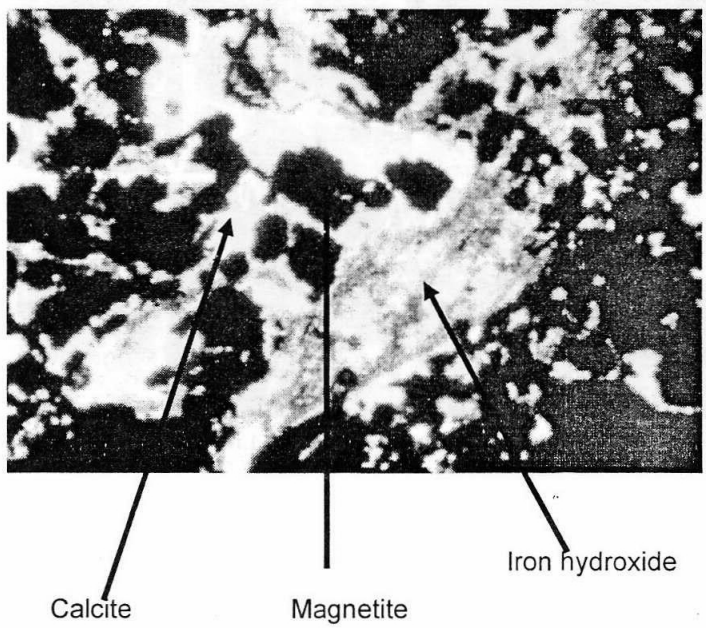

Fig. 2 : Photomicrographs of Calcite, Alonwith Goethite, Ilmenite Which Fills Magnetite Cavities (X40)

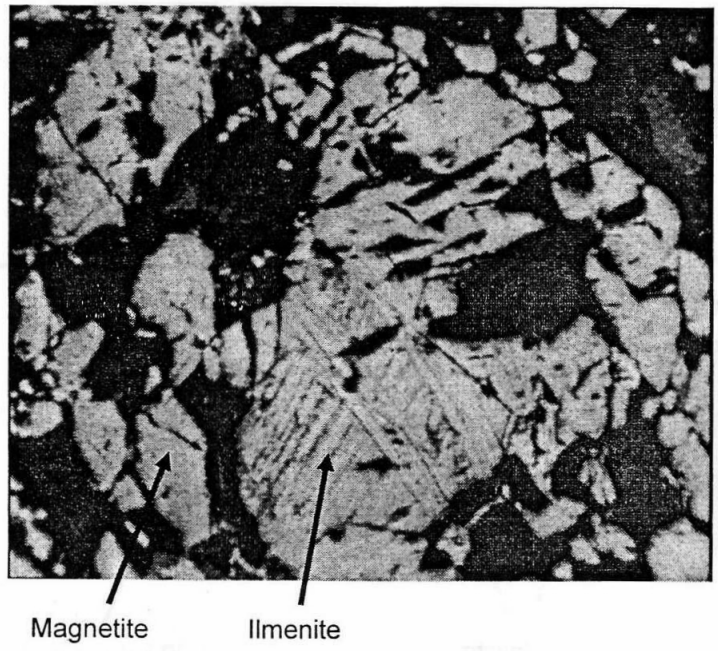

Fig. 3: Photomicrographs of Magnmetite and Ilmenite (X200)

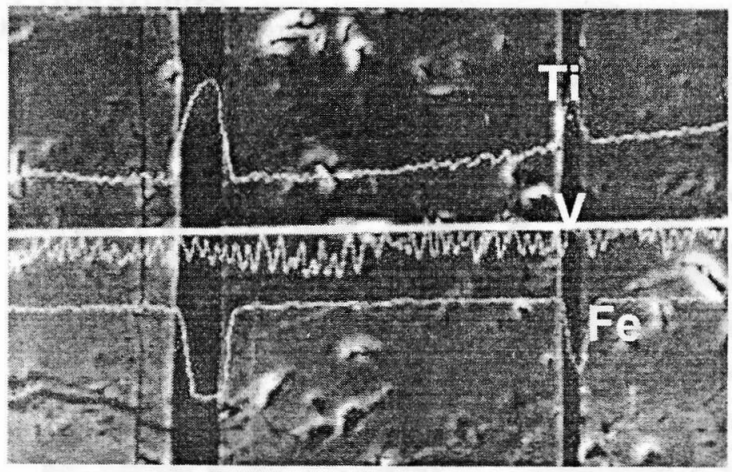

Fig. 4: Photomicrograph of Ilmenite and Magnetite Alonwith Line Analysis for Fe, Ti and V (X1000)

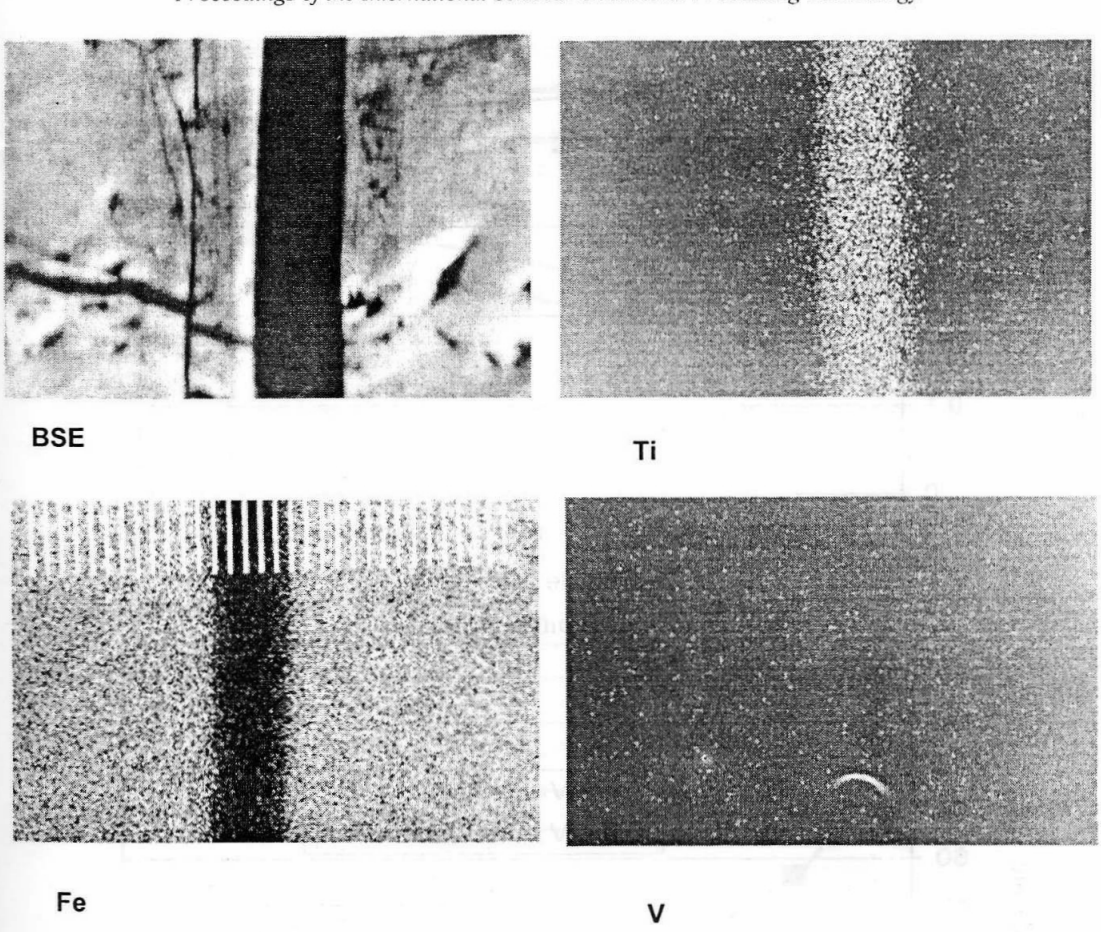

Fig. 5: Photomicrograph of X-Ray Map for Presence of V, Ti, and Fe (X2500)

PARTICLE SIZE ANALYSIS

The representative sample has been subjected to particle size and chemical analysis and the results of assay and distribution of vanadium in different sieve fractions are shown in Fig. 6 and 7 respectively.

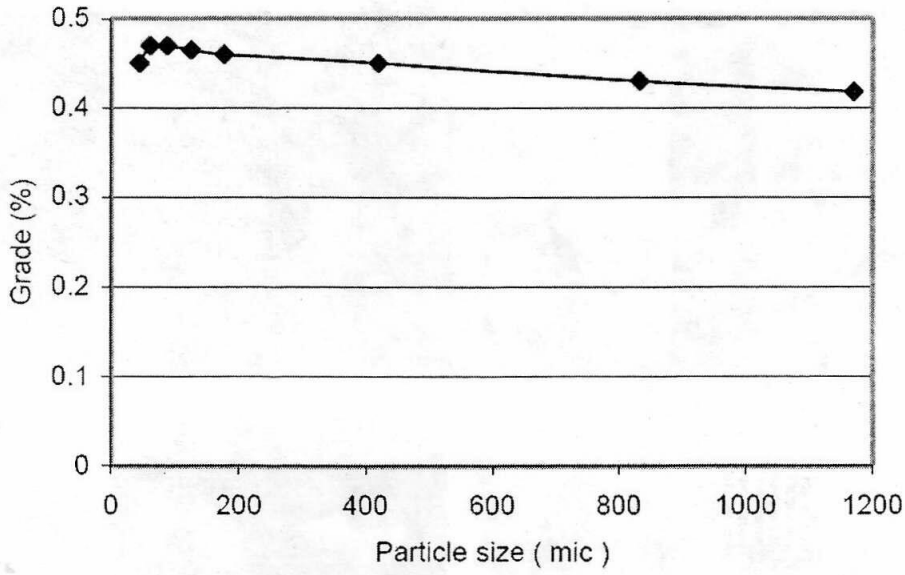

Fig. 6: Grade of V in Different Sieve Fractions

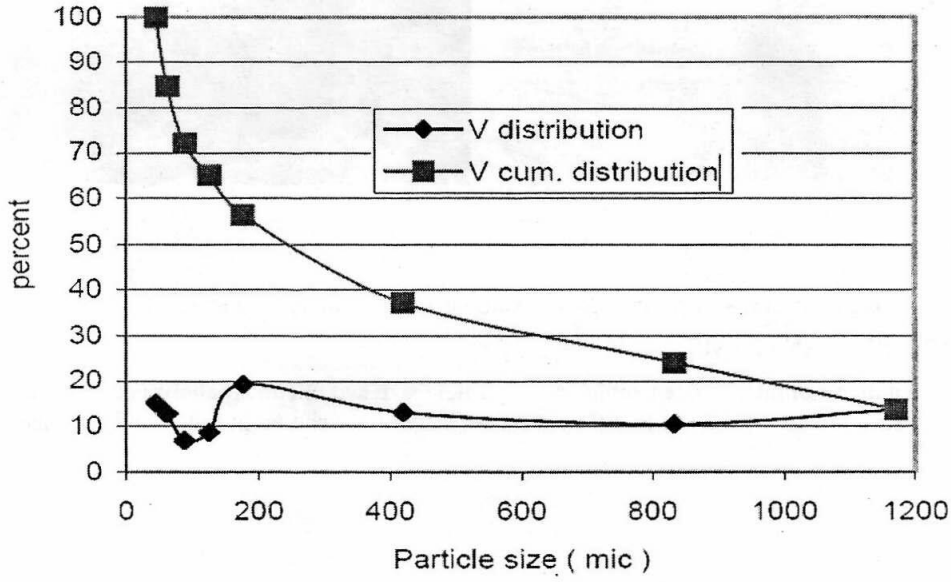

Fig. 7: Distribution in Different Sieve Fractions

DAVIS TUBE TESTS

The representative sample from each sieve fractions has been subjected to Davis tube test and the results of grade and distribution of vanadium in magnetite concentrates are illustrated in Fig. 8 and 9 respectively.

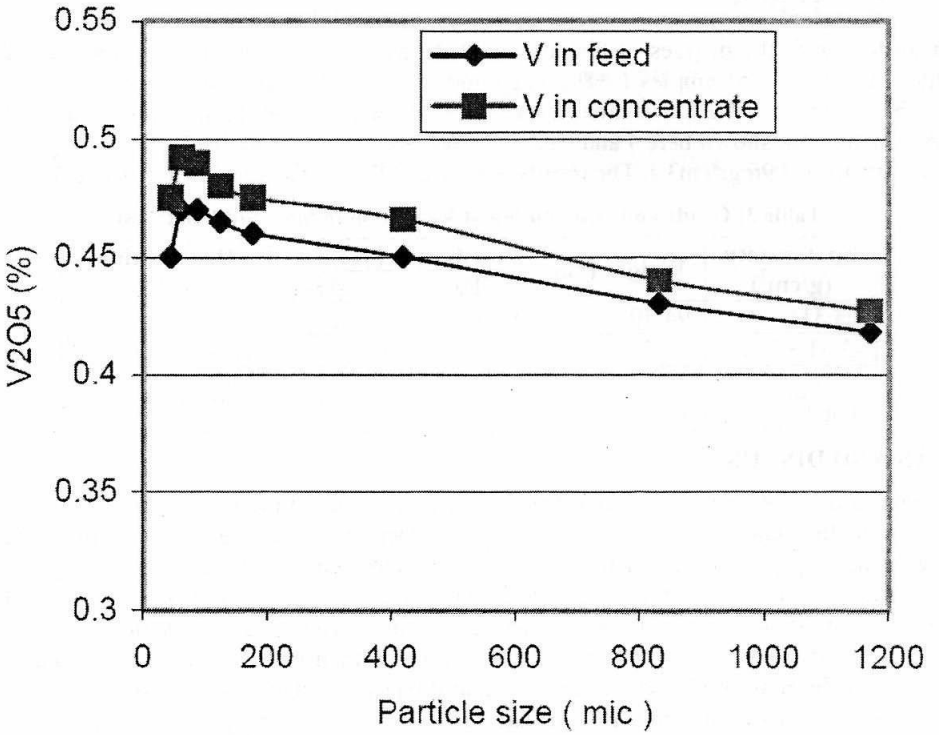

Fig. 8: Grade of Vanadium in Feed and Magnetic Concentrates

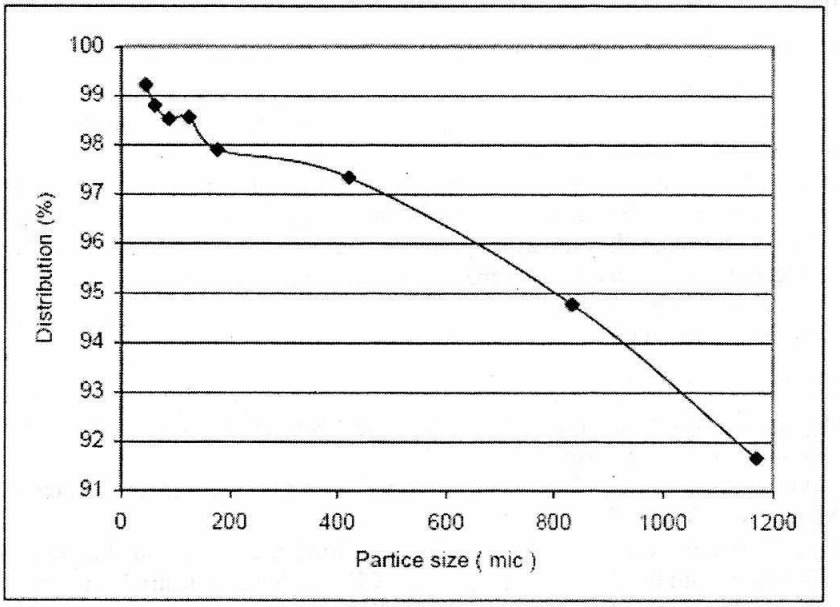

Fig. 9: Distribution of Vanadium in Magnetic Concentrates

LIBERATION STUDIES

In order to determine the degrees of liberation and the size at which magnetite graines are liberated from other impurities the samples (+80, +120 and +170 mesh) were subjected to grain counting method which confirms the Davis tube tests (approximate degrees of liberation was bellow 150 microns which is not shown here) and sink and float tests using diiodomethane (3.31 gr/cm3) and tetra bromo ethane (2.96 gr/cm3). The results of sink and float tests are shown in Table 3.

Table 3: Grade and Distribution of Vanadium in Sink and Float Test

Sp. Gravity (g/cm^3)	Weight (%)	Grade (%)		Distribution (%)
		Fe	V_2O_5	
+3.31	94.30	69.16	0.483	98.07
-3.31 +2.96	1.47	<20	0.241	0.76
-2.96	4.23	<20	0.128	1.17
Total	100	---	---	100

RESULTS AND DISCUSSION

With respect to the preliminary studies (Table 1, Fig. 1, 2 and 3) the main constituent minerals are magnetite, hematite, talc, calcite and apatite in the order of abundance. Most of the vanadium is concentrated in magnetite which is the product of substituation of vanadium with iron element in magnetite structure which has been confirmed by SEM studies (Fig. 4 and 5). With respect to Fig. 6 and 7 the concentration of vanadium is not confined to any particular sieve fraction and more or less uniformly distributed in all sieve fraction and it varies with iron oxides and further confirms the presence of vanadium as an elemental rather than any types of mineral. With respect to Fig. 8, 9 and Table 3 about 98.07% of vanadium is distributed in +3.31 gr/cm3 sink portion and at the same time grade of total iron was 69.16% with weight percentage of 94.3 (Table 3).

CONCLUSION

The following conclusions can be drawn from this investigation:

- Magnetite is the main constituent mineral present in which most of the vanadium is concentrated in it, not in the form of mineral but in an elemental form, which has been confirmed by SEM technique.
- The degrees of libration of magnetite from other matrix material is found to be bellow 150 microns which has been further confirmed by Davis tube test, sink and float tests and counting method.
- Based on charactrization studies it may be predicted that vanadium can be recovered by combination techniques like magnetite separation, roasting and leaching without uneffective destruction of magnetite mineral.
- Investigation carried out in this respect are either scanty or nil.

REFERENCES

[1] M. J. Magyar, (2003) "Vanadium", U.S. Geological Survey, Mineral Commodity Summaries, (703) G48- 4964 mmagyar@usgs.gov.

[2] M. S. Jakkiwar et al., (1977) "Utilization of Vanadiferous titanomagnetite" Trans. Of the Indian Ins. of Metals. Vol. 30. No.5 P: 285- 291.

[3] T. Grammatikopoulos, etal., (2002) "Vanadium- bearing magnetite and ilmenite ineralization and beneficiation from the Sinarsuk- Ti- project" CIM Bulletin- Industrial Minerals. P. 87- 95.

[4] L.M. Gonzalez and K. S. E. Forssberg, (2001) "Utilization of a vanadiumcontaining titanomagnetite: Beneficiation possibilities" Trans. Ins. Min. Metal. Vol 110. P. C63-C72.

[5] P. S. Banerjee and P. J. Roychoudhury, (1992) "Beneficiation studies on vanadiferous titanomagnetites" Journal of Mines, Metals and Fuels. Mineral Beneficiation. P. 143- 146.

[6] A.Jafarzadeh and M. B. Razavi, (1992) "Exploration and deposit of iron ore" Central Publication of Steel Industry in Iran. P. 5-15.

[7] P. C. Naganor etal, (2001) "The recovery of vanadium from titanoferous magnetite deposits of Masanagre, India- Inter. Jour. Of Eng. Science. Vol. 12. No 1. P. 39- 46.

[8] M. Roy and P. P. Bhatnagar, (1960) "Studies on the extraction of vanadium pentoxide from vanadium bearing titaniferous magnetite ore of Bihar and Orissa. NML Journal. P. 27.