Note on Occurrence & Potential of Vanadium in Graphite Schist, Tikari-Gauthana-Chiklar Block Betul, District Madhya Pradesh

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The Betul belt is a Palaeoproterozoic to Neoproterozoic, meta-volcanosedimentary sequence intruded by mafic-ultramafic & granitic suite of rocks and located between Son-Narmada South Fault (SNSF) in the north and the Gavilgarh Tan Shear (GTS) in the south. The metasedimentary / supracrustal litho-unit association dominate the western and northwestern part of the belt around Sonaghati and Chicholi areas whereas the volcano-sedimentary sequence dominates the eastern and central parts. The mafic-ultramafic complex outcrops are mainly in the western and north western part of the belt around Padhar and eastern part of the belt around Mordongri where it occurs in association with bimodal volcanics.

Since decades, Betul Belt is renowned for its potential of volcanic hosted massive sulphides but the recent augmentation of Graphite resources from Betul district had open the new realm of exploration. The basemetal mineralization is hosted within the volcano sedimentary sequence exposed in the eastern and central part of this belt where as the graphite deposits are mainly concentrated in the western part of the Betul inlier and are located in Chiklar-Gauthana-Tikari, Golighat-Junewani and Bhopali areas.

One of the India's largest Graphite deposit is reported and explored by Geological Survey of India in Tikari-Gauthana-Chiklar Block, Betul District MP. Within the block three graphite bands has been demarcated for a cumulative strike length of 3.75 km having width ranging from 5 to 135.0 m.

During FS 2015-16 (Item No 068/ME/CR/MP/2015/048), the exploration was taken up in strike length, of 1.25 km only, with width varying from 7.0 to 45.0 m, upto the vertical depth of 150m. The cumulative resources of 10.93 MT with an average of 8 to 11% FC was augmented. The part of the Block (Tikari- Gauthana) with resources 6.24 MT with an average grade of 8.79 % FC was auctioned in May 2018 with total revenue of the lease period 1884.34 Cr. Another part of the block is under process of auctioning with the resource 4.67 million tonnes with an average grade of 10.55 % FC

The random samples (25 numbers of core samples) for different rock units including Graphite schist, Quartz Mica Schist, Granites, Ambhibolite schists, Pegmatites and dolerite were analyzed at Chemical Laboratory, GSI, SR, Hyderabad by AAS method. Out of these 14 numbers of core samples were of graphite schist with fixed carbon ranging from 0.45 % to 18.50 % from borehole no BBT-08, 09, 11, 12, 13 & 14. The vanadium concentration in the samples of Graphite schist ranges from 254 ppm to 1848 ppm whereas it is below the crustal abundance in the samples from other litho-units. The correlation matrix indicates a strong positive correlation between Vanadium, Chromium, Yitterium and Fixed carbon (Fig.1.1). This was also visualized

in the Harker variation diagram with FC % as the differentiating index (Fig.1.2). The descriptive statistics of all these elements indicates that Vanadium concentration in these samples is above the crustal abundance (135 ppm) *Taylor 1964.* The threshold concentration of Vanadium calculated using Median +2 MAD (Mean Absolute Deviation) is 752 ppm. Therefore, 07 Nos of samples have concentration greater than the threshhold value. The histogram shows that the Fixed carbon has the Gaussian distribution with slight positive skewness and platykurtic nature where as that of Vanadium has the bimodal distribution with slight positive skewness and platykurtic nature.

The discrete population of randomly selected core samples indicates that the vanadium is intricately associated with the fixed carbon and vanadium is concentrated with the increasing percentage Fixed Carbon. The Bivariate statistics and correlation-regression ratio suggests that the samples with FC greater than 8 % have vanadium concentration above the threshold (752 ppm). Besides, it is worth mentioning here that no distinct Vanadium bearing mineral phase had yet been identified in the XRD studies. It gives the possibility for Vanadium being concentrated in the interstitial spaces of Graphite Flakes/ Micro Crystals.

The correlation of Graphite with Vanadium was initially carried out by GSI, Arunachal Pradesh and the association was established with Vanadium concentration upto 2200ppm within the samples of carbonaceous rocks having FC upto 19 %.

Conclusively, the high concentrations of vanadium within the Graphite schist enriches the potential of this huge deposit, which can be further established by the complete analysis of Core samples with FC content greater that or equals to 5 % . Thus, vanadium resources could be by-product along with the major commodity as Graphite, within the already auctioned blocks in Tikari-Gauthana- Chiklar area, Betul district MP and in the remaining areas which are yet to be explored in Betul belts and all over the country.

	Ba	*V*	*Pb*	*Ni*	*Co*	*Y*	*Cr*	*Cu*	*Zn*	*FC*
Ba	1.00									
V	-0.46	1.00								
Pb	-0.29	-0.04	1.00							
Ni	-0.64	0.83	0.23	1.00						
Co	0.22	-0.18	0.53	0.03	1.00					
Y	-0.49	0.87	0.03	0.81	-0.18	1.00				
Cr	-0.36	0.98	-0.08	0.78	-0.23	0.86	1.00			
Cu	-0.57	0.76	0.33	0.93	0.24	0.74	0.67	1.00		
Zn	-0.63	0.63	0.27	0.86	0.18	0.62	0.53	0.86	1.00	
FC	-0.37	0.91	-0.21	0.66	-0.29	0.73	0.87	0.61	0.46	1.00
	Strongly Correlated (>0.85)			Moderately correlated (0.85 to 0.65)				Slighly Correlated (0.65 to 0.50)		

Fig.1.1. The correlation Matrix of the Core samples of Graphite schist, Tikari Gauthana, block Betul

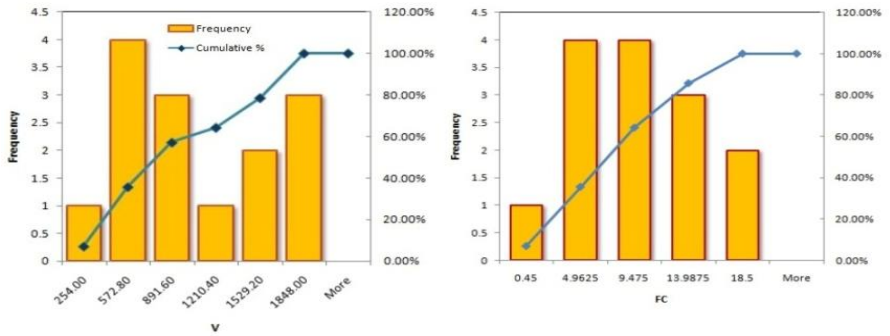

Fig.1.2. Histogram of core samples for Vanadium and fixed carbon concentration.

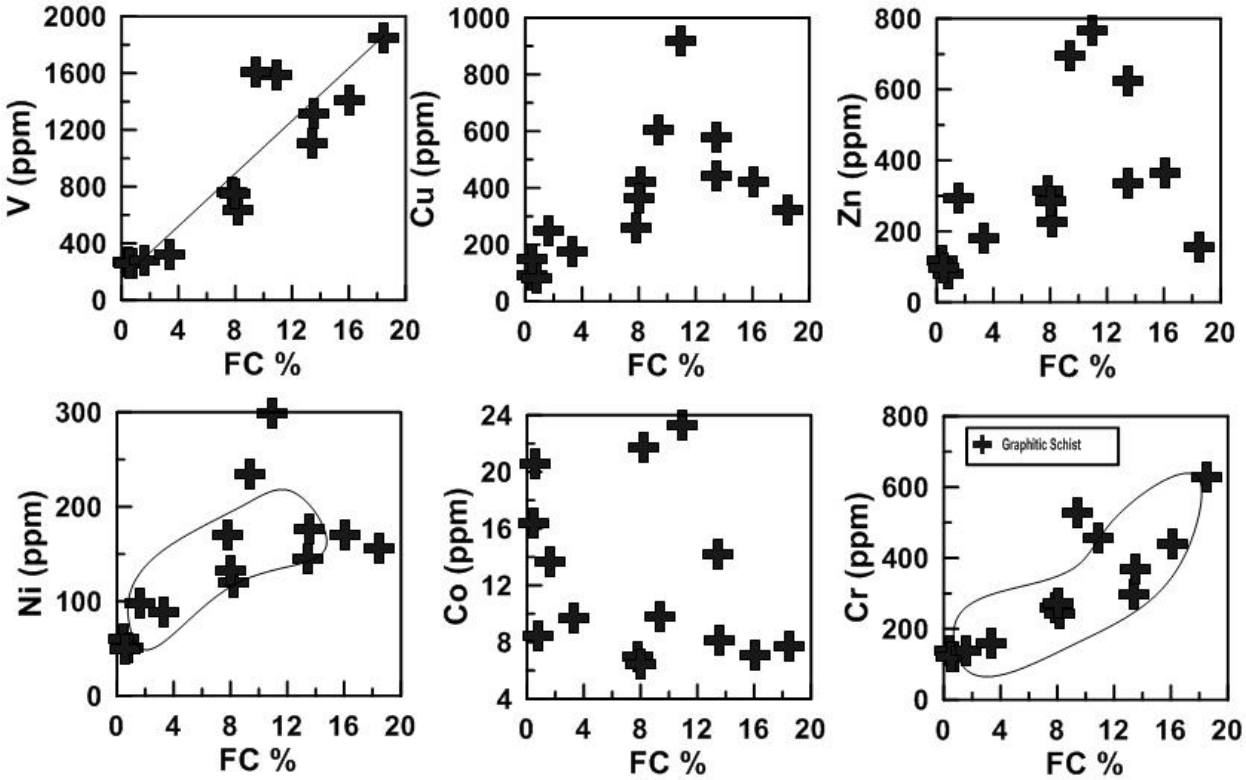

Fig.1.3. Harker variation plots with Fixed Carbon (FC%) as the differentiating index.

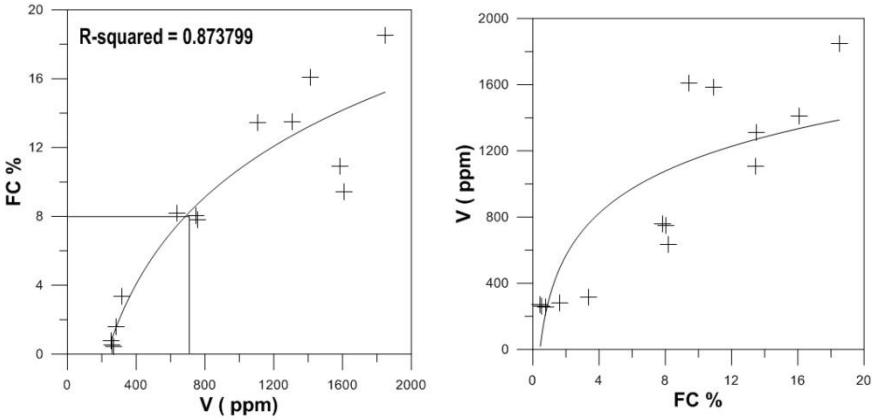

Fig.1.4 Correlation of Fixed carbon & vanadium and REE.