Role of Vanadium in Carbonatite Magma at Amba Dongar Diatreme Gujarat, India From Magmatic to Hydrothermal

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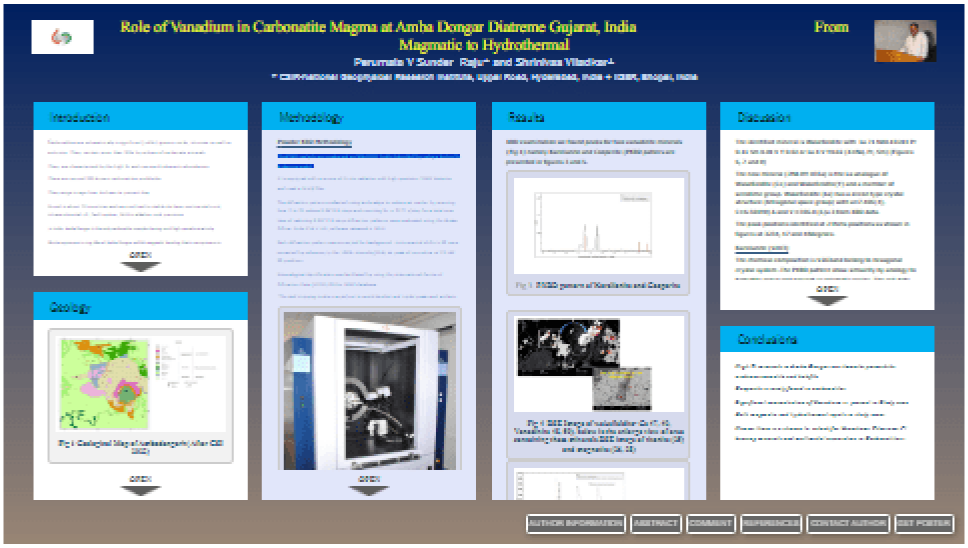

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PRESENTED AT:

INTRODUCTION

Carbonatites are volumetrically insignificant (~4%) igneous rocks, intrusive as well as extrusive. They contain more than 50% by volume of carbonate minerals.

They are characterised by the high Sr and rare earth elements abundances

There are around 529 known carbonatites worldwide

They range in age from Archean to present day

Found in about 70 countries and are confined to stable Archean continental crust, intracontinental rift, fault system, Within alkaline rock provinces

In India Amba Dongar is the only carbonatite complex having such high vanadium activity.

Sövite exposures in ring dike of Amba Dongar exhibit magmatic banding that is conspicuous in some parts of the ring dike.

The bands are usually rich in magnetite, titanite, apatite and pyrochlore (Fig. 1). In addition to banding some exposures show randomly oriented extensive veins containing secondary hydrothermal minerals.

These veins are rich in barite, REE-minerals and vanadinite. Barite and magnetite are ubiquitous in Amba Dongar carbonatite .

In the samples studied barite occurs in close association with vanadinite and magnetite.

Magnetite is abundant in these sövite and it forms thick bands (~2 cm) as well as disseminated grains.

Vanadinite occurs in the vicinity of barite, titanite and magnetite (BSE figures 2 and 3).

GEOLOGY

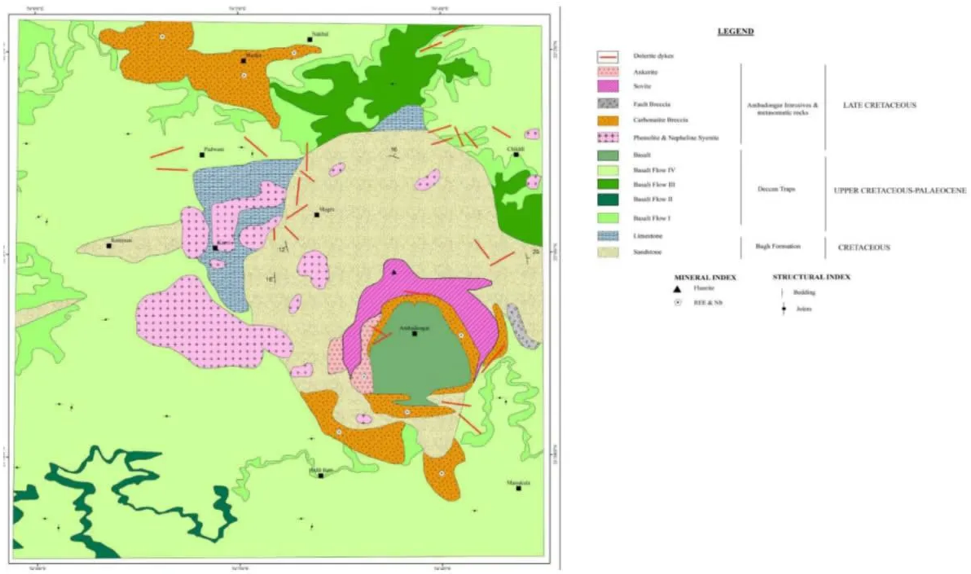

Fig 1 Geological Map of Ambadongarh(After GSI 2022)

The Ambadongar Carbonatite (Fig 1) is located in Chottanagpur district, Gujarat State,India.

Majority of the area is covered by tholeiitic lava flow of Deccan Traps.

The complex consist of a Sovite ring dyke that has an inner rim of carbonatite breccia.

The diatreme is sourrounded by a Fenite zone at the conatct with the Bagh sandstone.

The first pahse is of thin dykes intruding sovite and fenite.

The second phase form large plugs within sovite ring dykes

The last phase is enriched with REE and Nb and end with flourite mineralization (Fig 2 below)

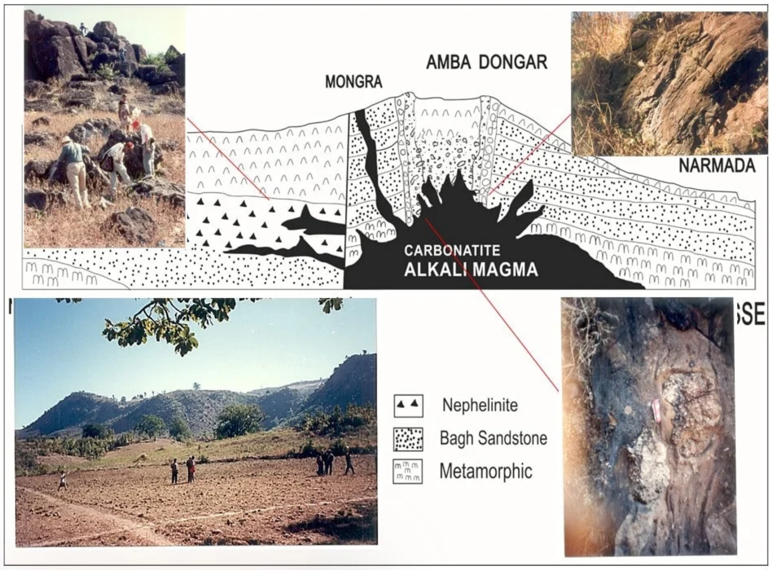

Fig 2 Geological features of theAmba Dongar area

METHODOLOGY

Powder XRD Methodology

The PXRD analysis was conducted at CSIR-NGRI, India X-Ray facility, using a Bruker D-8 advance model.

It is equipped with a source of Cu Kα radiation with high precision LYNXE detector and used a Ni Kβ filter.

The diffraction patterns collected using knife-edge to reduce air scatter by scanning from 5 to 70 reduce 0.02°2 θ steps and counting for ≈ 3177 s/step for a total scan time of reducing 0.02° 2 θ steps diffraction patterns were evaluated using the Bruker Diffrac. Suite EVA V 4.0, software released in 2016.

Each diffraction pattern was corrected for background. Instrumental shifts in 2θ were corrected by reference to the 100% intensity (104) Kα peak of corundum at 35.149 2θ positions.

Mineralogical identification was facilitated by using the International Centre of Diffraction Data (ICDD) PDF4+ 2022 database.

The Kα2 stripping is also carried out to avoid doublet and triplet peaks and artifacts

PXRD

or match fit.

Scanning electron Microscope

The system is a LEO440 device, from Oxford instruments, operated at 15-20Kv with variable voltage ranging between 2-5 nA.Filament was working at the first maximum, about 2.5 nA**.**

RESULTS

XRD examination we found peaks for two vanadinite minerals (Fig 4) namely Karelianite and Cooperite (PXRD patters are presented in figures 3 and 5.

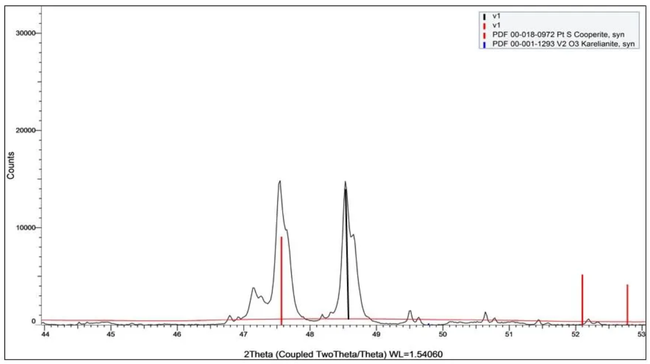

Fig 3- **PXRD pattern of Karelianite and Cooperite**

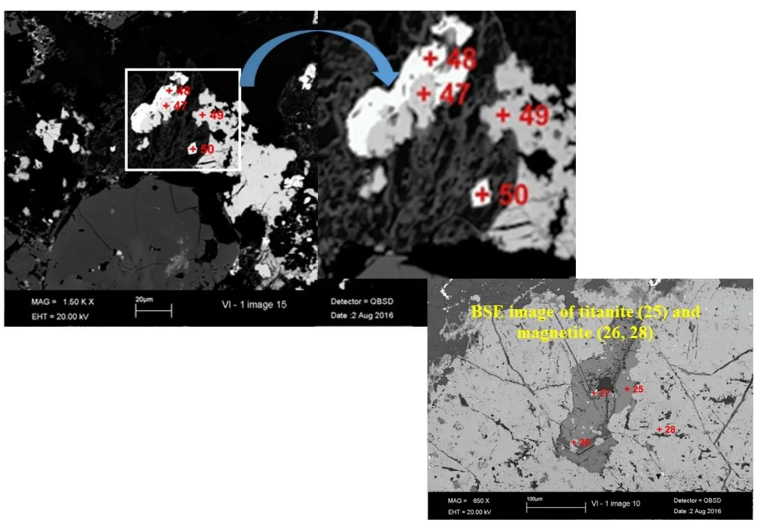

Fig 4 BSE Image of wakefieldite- Ce 47, 49, Vanadinite 48, 50), below is the enlarge view of area containing these minerals.BSE image of titanite (25) and magnetite (26, 28)

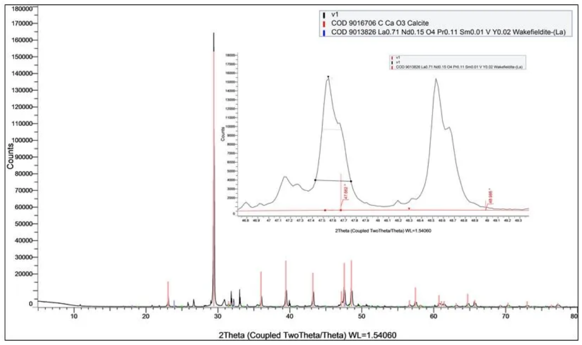

Fig 5 PXRD pattern of Wakefeildite 0-70 degrees and also enlarged inset

DISCUSSION

The identified mineral is Wakefieldite with La 71 Nd0.15O14 Pr 0.11 Sm 0.01 V Y 0.02 or La X V Y0.02 (X=Nd, Pr, Sm) (Figures 6, 7 and 8)

The new mineral (IMA 89-035a) is the La analogue of Wakefieldite (Ce) and Wakefieldite(Y) and a member of xenotime group. Wakefieldite (La) has a zircon type crystal structure (tetragonal space group) with a=7.406(4), C=6.50498) A and V =356.8 (6)a 3 from XRD data.

The peak positions identified at 2 theta positions as shown in figures at 3234, 47 and 48degrees.

<u>Karelianite (V_2O_3)</u>

The chemical composition is $V_2O_3$and belong to hexagonal crystal system .The PXRD pattern show simlairity by anology to hematite group and present as prismatic grains .The cell data with space grou isR3C a= 4.99, c=13.98 Z=6. It is associated with Pyrrhotite, chalcopyrite, pyrite, tremolite, graphite, titanite, quartz (Outokumpu mine, Finland); corvusite, montroseite, uraninite, quartz (Mounana mine, Gabon); millerite, violarite, montroseite (Guangxi, China). Because the vanadium-oxygen bonds have some covalent character $V^{+3}$is chosen as a compromise between unionized V and fully ionized V^{+5} (Trotter and Barnes 1958).

<u>Cooperite</u> belong to Tetragonal crystal system and, space group P42/mmc. with Unit cell data: a 3.465 Å, c 6.104 V 73.29 Å3, Z 2. Class: 4/mmm; c:a= 1.7616.The crystal structure is of PtS type with strong and directed covalent bonds. M (M = Pt, Pd) forms four co-planar bonds with X (X = 0, S), which itself is coordinated by four M in a distorted tetrahedral environment.The standard X-ray powder diffraction data: 3.013 (100) (011), 2.450 (60) (110), 1.911 (80) (112), 1.753 (60) (013), 1.732 (50) (020), 1.507 (70) (022), 1.231 (50) (123).

CONCLUSIONS

High Ti minerals in Amba Dongar are ilmenite, perovskite, niobianzirconolite and betafite

Cooperite is rarely found in carbonatites

Significant concentration of Vanadium is present in Study area

Both magmatic and hydrothermal inputs in study area,

Hence, there is a chance to relook for Vanadium, Titanium, Pt bearing mienrals and multimetal association in Carbonatities .

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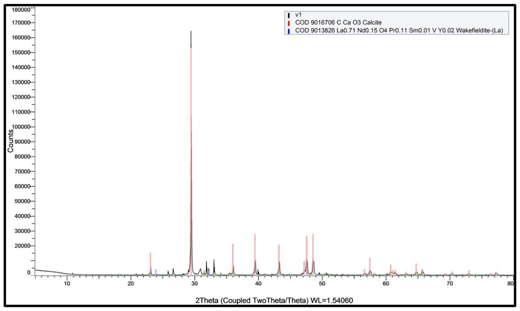
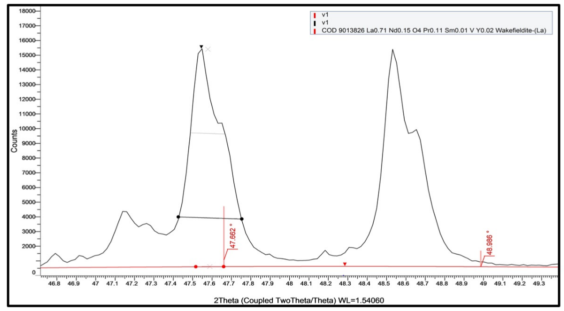
ABSTRACT

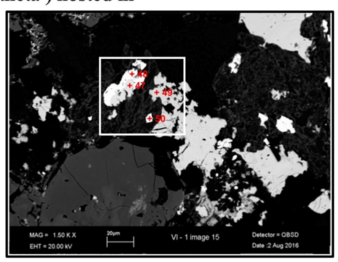
In carbonatites high vanadium concentration is not common and it is usually present in trace amounts in spinel, titanite or magnetite and some ferromagnesian silicate minerals. V-minerals (vanadinite, wakefieldite) have not been reported from magmatic carbonatites barring some volcanic carbonatites of Italy. In Amba Dongar sövite, however both these minerals along with Karelianite and Platinum group mineral-cooperate have been detected. It is noted that vanadium in low concentration is found in magmatic stage while its concentration reaches high enough in hydrothermal solutions to form vanadinite, wakefieldite and karelianite. So far perhaps Amba Dongar is the only carbonatite complex having such high vanadium activity.



XRD Pattern of whole range of 2theta from 2-70 degree .(Wakefiledite at 47 and 48 degree 2theta) hosted in Calcite



XRD pattern showing Wakefieldite (2thete angle)



BSE Image of wakefieldite- Ce 47, 49, Vanadinite 48, 50), below is the enlarge view of area containing these minerals.

(https://agu.confex.com/data/abstract/agu/fm22/1/9/Paper_1049091_abstract_952128_0.jpg)

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