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SEM Analysis of Host Rocks of Uranium of Tummalapalli, YSR District, Andhra Pradesh, India

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Abstract
Uranium is one of the chief, rich resources produced by India and it is also occurring many parts of the country in general and Tummalapalli, Andhra Pradesh and Jadughuda, Jharkhand in particular. It is one amongst many economic mineral deposits derived from the crescent shaped Proterozoic Cuddapah basin in India. The Cuddapah basin is middle – upper Proterozoic basin of Andhra Pradesh endowed with rich minerals of economic importance along with Unconformity related strata bound Uranium deposits. The dolostones of composition $CaMg(CO_3)^2$ belongs to Vempalli formation are host rocks and granites of Archaean basement are the source rocks for the Uranium mineralization especially in Cuddapah basin. It is mainly occurring in Thummalapalli area of YSR district in Andhra Pradesh. The present study is intended to investigate the Geochemistry of host rock formations of Uranium mineralization using the Scanning Electron Microscope (SEM).

Key words: Uranium, Geochemical analysis, SEM, Thummalapalle. Cuddapah basin.

Introduction

The Cuddapah basin is a middle – upper Proterozoic basin of Andhra Pradesh endowed with rich mineral wealth (Senthil Kumar et al, 2005; Ramachandra, M., et al., 2018). The principle ore Uranium in Tummalapalli is the oxide of Uranium UO_2. It is the Archean basement unconformity that provides the most potential host for World's largest Uranium deposits. The unconformity overlying the Archean granite basement, belongs to the lower middle Proterozoic age found in Australia, Canada (Hoeve et al.2005). In India the unconformity related to Uranium deposits are found in south western part of the Cuddapah basin of Andhra Pradesh. It was discovered in late 1950's in Cuddapah basin of Andhra Pradesh. Exploration in 1980's and early 1990 has brought out an unconformity related significant Uranium mineralization in phospatic dolostones (sinha et al. 1995). The exploration and research by Atomic Mineral Division (AMD) in Cuddapah basin led to the recognition of three distinct type of Uranium mineralization namely 1) Strata bound deposits, 2) Fracture controlled deposits, 3) unconformity related deposits. The stratabound Uranium deposits are hosted by carbonate rocks are a unique deposits and no such Uranium mineralization reported in the world. It extends over a belt of 160 km from Chelumapalle in northwest to Maddimadugu in the south-east to with most promising deposits at Thummapalli area of YSR District.

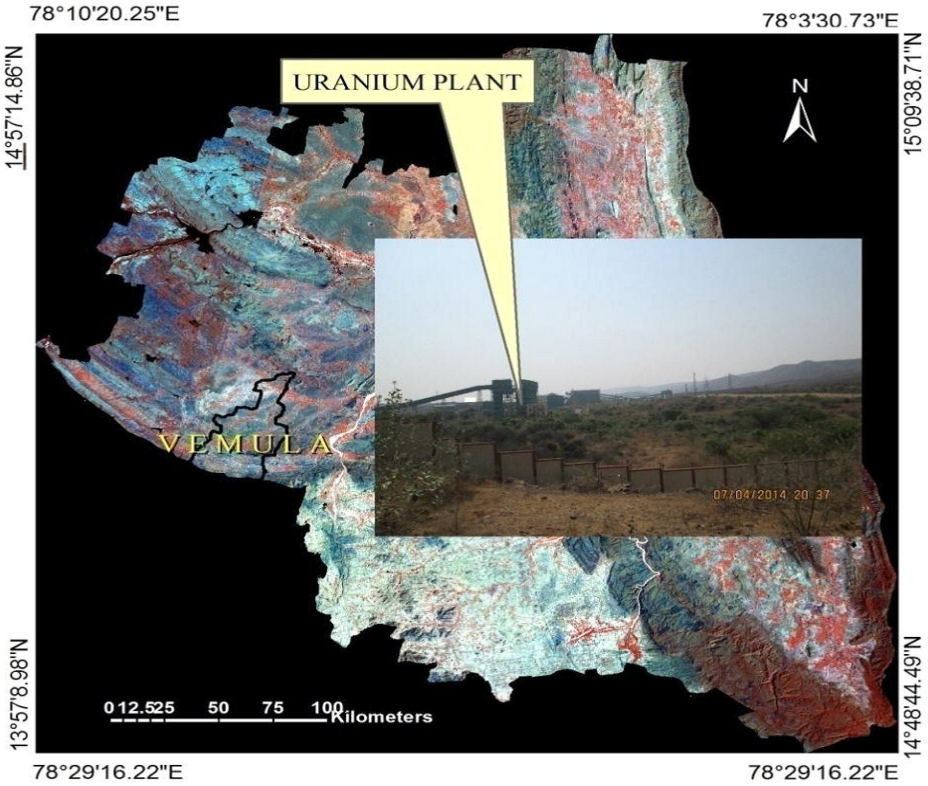
Scanning Electron Microscope (SEM)

A Scanning Electron Microscope (SEM) is a type of electron microscope that harvests images of a sample by scanning the surface with an attentive beam of electrons. The electrons interrelate through atoms in the sample, creating numerous signs that cover evidence about the surface topography and composition of the sample. The electron beam is scanned in a raster scan pattern, and the site of the beam is combined with the intensity of the detected signal to produce an image. In the most common SEM mode, subordinate electrons emitted by atoms excited by the electron beam are detected using an Everhart-Thornley detector. The number of secondary electrons that can be detected, and thus the signal intensity, be contingent, amongst other things, on specimen topography. SEM can achieve resolution better than 1 nanometer. Specimens are observed in high vacuum in conservative SEM, or in low vacuum or wet conditions in variable pressure or environmental SEM, and at a wide range of cryogenic or elevated temperatures with specialized instruments.
Usually the particle size less than 0.2 microns we cannot be resolved under the ordinary microscope, hence we cannot be seen. In the scanning electron microscope (SEM) we can reveal information about the sample including external morphology, chemical composition and crystalline structure and orientation of materials making up the sample (B. Pradeep Kumar et al.; 2019). EDAX (Energy Dispersive X – Ray Analysis) is the system software is used to analyze the energy spectrum in order to determine the abudence of specific element present in the sample. EDAX can be used to find the chemical composition of minerals present in the sand grains. A typical EDAX is portrayed as a plot of X- ray couts vs energy (in keV) (severin et al.; 2004, clarke, A.R 2002).

Study area

The Uranium mineralization occurring in south-western part of the YSR District are stratabound deposits hosted by carbonate rocks of impure phosphatic dolostones of the Vempalle formation of the Papaghni group. The promising Uranium deposits occurs at Tummalapalle, Rachakuntapalle and Mabbuchintalapalle villages of Vemula mandal within the latitudes of $14^0$17`24.818``N to $14^0$30`42.663``N and longitudes of $78^0$3`559`` to $78^0$23`56.723``E (Fig.1)

Fig.1 Location map of the study area



Geology and Stratigraphy

This area is primarily composed of quartzites, limestones, dolomites, shales and ultrabasic igneous intrusives. The lower most strata of this area is quartzite belonging to the Gulcheru formation of Papaghni group of lowermost Cuddapah Supergroup. Overlying this formation, there are dolomites related to the Vempalle formation of the Papaghni group of Cuddapah Supergroup of rocks which are principal source rocks for asbestos mineralization in the entire study area. Above which there are quartzites belonging to the Vempalle formation. These rocks are followed by quartzites of Pulivendla formation of Chitravati group of middle Cuddapah Supergroup of rocks and in turn followed by Shales of Tadipatri formation of Chitravati group of Cuddapah Supergroup of rocks. The Vempalle dolomites, Pulivendla quartzites and Tadipatri shales contain ultrabasic igneous intrusions in the form of sill bodies (B. K. Nagaraja Rao, et al, 1987).

Origin and Occurrence of Uranium

The strata bound Uranium-mineralization in the study area is one amongst unique deposits in the world in the sense of carbonate rock hosted Uranium deposit reported in the world. There are several promising features explaining the hosting of Uranium mineralization in Cuddapah basin. It includes Proterozoic age, fertile granite basement, varying lithologies, post depositional structures like major fault and shear zones, post sedimentation igneous activity (Anand et al., 2003). The mineralization within the impure phosphatic dolostone of Vempalle formation along the bedding plane mainly in the form of vanadium-bearing pitchblende and U-Si-Ti complex (Vasudeva Rao et al., 1989; AMD, 1995). The main source of phosphorus – Uranium in these sediments is the basement granite. During the major transgressions and rapid flooding of coastal plains, iron, phosphorus, silica, Uranium and organic matter may have contributed (Zakaulla et al., 2009). The Uranium in this area is associated with pyrite, molybdenite, chalcopyrite, bornite, digenite and covellite. The deposit is low grade containing 0.28% UO_2. A syngenetic origin is contemplated for this mineralization

Sample collection

In mining site five fresh samples have been collected by chipping method. Each sample is collected at 10 Meters interval in a stretch of 1 Km. After collecting the samples, they are well washed to remove dust and mud. The samples have been powdered and sent for analyzing those samples in Scaning electron microscope (SEM) with EDX.

Plate–1 Field photo showing the Tummalapalli Uranium Plant

Methodology

Rock samples were analyzed in Hitachi SU-1500(VP-SEM), ZEISS and JOEL (JSM-IT 500) at variable pressure in Scanning Electron Microscope to study the morphological features of these uranium hosted dolostones. A powerful method in material analysis is Scanning Electron Microscopy (SEM). Here a sample surface is scanned with a excellently focused electron beam. The resulting electron attack leads to the emission of secondary electrons, back sprinkling of high energy primary electrons and creation of element specific x-rays. Several detectors are available in Electron Microscopy all with their advantages. SE detectors only collect low energy secondary electrons originate from the top nanometers of the sample. It stretches outstanding superficial topography imageries with very sensible resolution. EDX-APEX model is used to know the chemical characterization or element analysis on the sample surface. Energy Dispersive X-rays Spectroscopy (EDX or EDS) is an analytical capability were element specific radiation is used for chemical characterization of the surface near volume. With the assistance of appropriate detectors, the energy or the x-rays is determined. It can be coupled with several applications including SEM, Samples were placed on Aluminium disk using double sided tapes. The electron beam collides on the surface of the selected samples with the intensity range from micrometers to nanometers. The EDX analysis has shown various major, rare earth, trace elements.

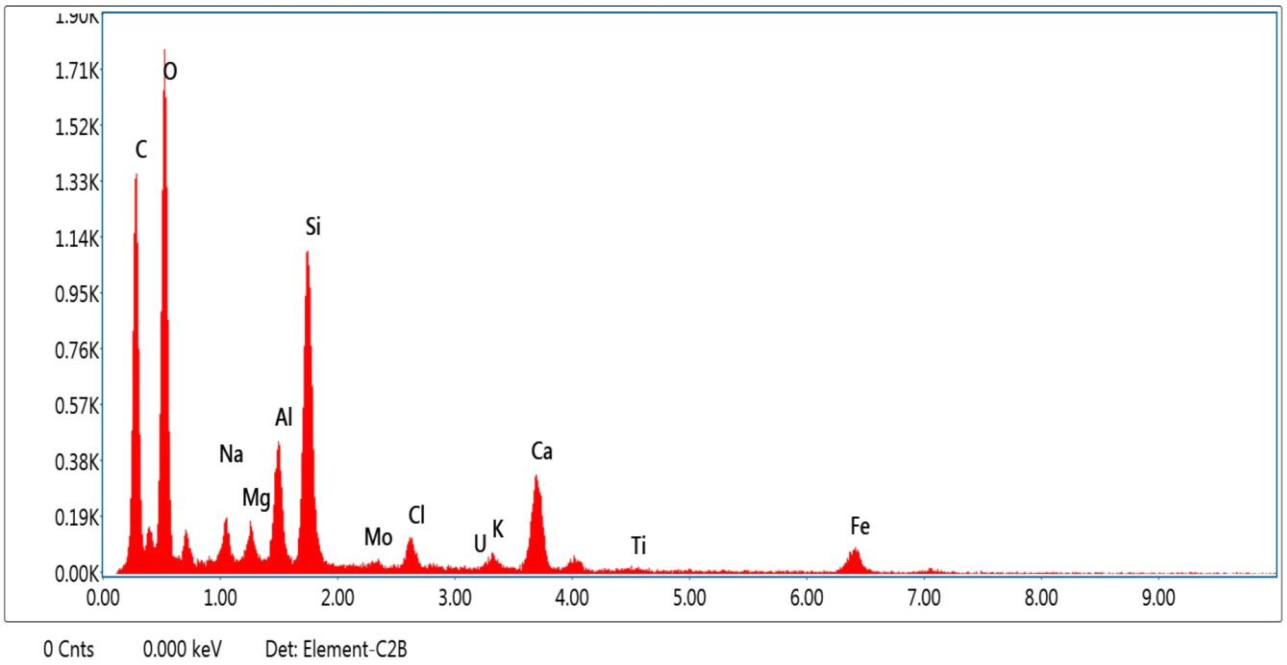
Results and Discussions

The dolostone rock sample was analysed with SEM and EDX for the identification of materials, classification of materials, for examination of morphology, particle size and shape analysis. The SEM-EDX analysis of uranium bearing dolostones in the Tummalapalli area shows enrichment of elements like oxygen followed by carbon in the order of 33.65%, 29.98% in weight% and 43.95%, 37.17% in atomic % respectively. Next to these two samples is silica and calcium and iron which are 10.07% by weight% and 6.34% by atomic%; 8.37% by weight% and 3.69% by atomic%; 6.71% by weight% and 2.12 by atomic% respectively. The present sample showing Uranium of 0.28% by weight% and 0.02% by atomic%. The other elements present in the sample are sodium(Na), magnesium(Mg), alluminium(Al), molybdenum(Mo), chlorine (Cl), potassium(K), Titanium(Ti) (Table-1). Graph showing the SEM-EDX analysis clearly shows the enrichment of all the elements with long and tiny peaks (Graph 1). Further the analysis shows enrichment of Ca, Mg, C, O forming $CaMg(CO_3)^2$ for the substance is dolostone.

Table 1: Element analysis by using EDX

Element	Weight %	Atomic %	Nt.Int
C	29.98	43.95	140.64
O	33.65	37.17	210.72
Na	2.23	1.71	21.87
Mg	1.31	0.95	20.12
Al	3.96	2.59	67.64
Si	10.07	6.34	187.32
Mo	0.56	0.10	4.10
Cl	1.49	0.74	19.25
U	**0.28**	**0.02**	**1.75**
K	0.77	0.35	8.02
Ca	8.37	3.69	72.19
Ti	0.71	0.26	4.96
Fe	6.71	2.12	23.76

Graph 1 Showing elements analysis



SEM photograph showing both crystalline and round grains with different grain sizes. The rounded grains at some places occur as nodule like structures probably of calcite or silica in composition (Plate-1). However, these structures indicate deep marine depositional conditions (Neuendorf et al., 2005; Boggs S, Jr., 2009).

Plate 1 SEM Photograph of Dolostone

Conclusions

In the present study SEM-EDX analysis is done for dolostone, the host rock of uranium in order to identify the materials, classification of materials, for examination of morphology, particle size and shape analysis. The SEM analysis shows the morphology of the dolostone like shape, size and mutual relationship of the particle within the rock sample. In EDX shows trace elements, rare earth elements and major elements. analysis of uranium bearing dolostones in the Tummalapalli area shows enrichment of elements like oxygen followed by carbon in the order of 33.65%, 29.98% in weight% and 43.95%, 37.17% in atomic % respectively. Next to these two samples is silica and calcium and iron which are 10.07% by weight% and 6.34% by atomic%; 8.37% by weight% and 3.69% by atomic%; 6.71% by weight% and 2.12 by atomic% respectively. The present sample showing Uranium of 0.28% by weight% and 0.02% by atomic%. The

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