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Uranium Mineralization in Mizoram: Inferences from Geochemistry

Rahul Verma[1], Shiva Kumar[2]
[1]Department of Mining & Geological Engineering, BIUST, Botswana
[2]Department of Geology, Mizoram University, India

Abstract: ***Mizoram state is covered by green-capped hilly terrain consisting of sedimentary rocks of Oligocene to Miocene age. The lithology consists of thickly bedded sandstones, shales and mudstones of various colours. Mogak Group consisting of Gneisses, Schists, and Kalibag Granites are exposed in the northern Myanmar, which may be the source region of these uraniferous sediments. River 'Chimtuipui (Kaldon)" draining from Arakan-Yoma Hill Ranges of Northern Myanmar to Mizoram, may have been the carrier for the Uraniferous sediments.***

The various primary sedimentary structures characterizing the Surma sediments are indicative of shallow marine to deltaic environment of deposition with a constant south worthy palaeoslope.

Several positive indications for such uranium mineralization have been found in the study area around Aizawl, Mizoram.

The higher concentration of Radon222 in the soils and vegetables of the neighboring states of northeastern India, such as 0.25 ppm in cereals, 0.44 in fruits, 0.77 ppm in leafs and 2.67 ppm in soils, strongly indicate the possibilities of uranium mineralization.

Further, the geochemistry of the sedimentary rocks of the study area reveals relatively higher U content (> 4ppm). Eh/pH range of these rocks suggest a sea water condition under 'euxinic condition'.

The Eh/pH ratio as inferred by the average U/Th ratio of the representative samples of the study area, reveal that the probable mineralization may be Uraninite. Positive indications for uranium mineralization may lead to fruitful result after further detailed studies.

Keywords: Eh, pH, UO_2, U/Th Ratio, $Radon^{222}$

I. INTRODUCTION

The Mizoram state (latitude $22^0 00'$-$24^0 30'$ and longitudes $92^0 15'$-$93^0 25'$) lies in the northeastern part of India, and is bordered by Myanmar in the southeast and Bangladesh in the west. The area consists of hilly terrains exhibiting nearly north south trend and is covered with green vegetation. The rock types are predominantly sandstones, shales with minor limestones of Barail, Surma and Tipam Groups. The location of the study area is shown in Fig.1.

A. Geoenvironment Of Uranium Deposits

The average uranium content in granitic rocks is as high as 4 ppm (Table-1) and is represented by a variety of minerals in nature, while the average uranium content in earth crust is 2 ppm only. Uranium is rarely found as an economic deposit (Keller, 1985). In general the major uranium deposits are associated with the Precambrian age rocks. However, Bowie (1970) has pointed out a probability that uranium may be concentrated in younger sedimentary rocks, through the redistributing agents such as shallow groundwater or surface water, where the provenance is older magmatic rocks. As a matter of fact, detrital sandstones of fluviatile, littoral, or lacustrine origin, host more than 40 % of the presently available low cost uranium and more than 95 % of the USA resources. Moreover, report of uranium from Middle Siwaliks in the vicinity of Potwar locality in Pakistan, associated with wood logs, clay balls, fossils etc. further strengthen this view (Qureshi et al., 1988).

Metamorphosed sandstone type uranium deposits of younger age (less than one million years) have been reported from Wadi Sikait, South Eastern Desert, Egypt, with a Uranium content ranging from 15-480 ppm. (Ibrahim et al., 2010).

B. Geological Setting Of Mizoram

The sandstones, shales, silt, and rare pockets of shell limestone of Mizoram, are divided into four major Stratigraphic units. The Stratigraphic succession after G.S.I (1974) and Ganju (1975) is presented in the Table-2.

Among various litho-units the Tipam Group is dominant in the western and northwestern parts of Mizoram only in the cores of the synclines. The Bokabil rocks also follow the similar distribution pattern. The Upper Bhuban rocks in the western Mizoram occupy the anticlinal position. The Middle Bhuban succession is exposed generally on the limbs of the folds but they also occupy the core of the low amplitude anticlines. The Lower Bhuban is confined exclusively to the anticlinal cores of high amplitude fields (Jokhan Ram et al., 1984).

C. Geology Of Sedimentary Uranium Deposits

Sandstone uranium deposits occur in medium to coarse-grained sandstones deposited in a continental fluvial or marginal marine sedimentary environment (Lambert et al, 1996). Impermeable shale/mudstone units are interbedded in the sedimentary sequence and often occur immediately above and below the mineralized sandstone. Uranium precipitates under reducing conditions caused by a variety of reducing agents within the sandstone including: carbonaceous material (detrital plant debris, amorphous humate, marine algae), sulphides (Pyrite, H_2S), hydrocarbons (petroleum), and inter bedded basic volcanics with abundant ferro-magnesian minerals (e.g. Chlorite).

Uranium in the sandstones is often found in form of lenses inter bedded with mudstones (Finch et al., 1973). Sandstone deposits constitute about 18% of world uranium resources. Ore bodies of this type are commonly low to medium grade (0.05 - 0.4% U_3O_8) and individual ore bodies are small to medium in size (ranging up to a maximum of 50000 t U_3O_8). The main primary uranium minerals are Carnotite and Tyuyamunite.

Sedimentary mineralization can be originated through the reduction and absorption of mobile uranium compounds in depositional environments. The principal reducants or absorbents are carbonates, carbonaceous matter and plant detritus. The sedimentary digenetic uranium deposits of these kinds are known to occur in the strata of Paleozoic, Mesozoic and Cainozoic age (Smirnov 1983, Solovov, 1987, Hoefs, 1997, and Mook 2006). Uraniferous conglomerates, sandstones and clays occur in thick sequences of alluvial - proluvial facies, which get accumulated in the piedmont area.

U mineralization in brecciated Mississippian carbonate rocks near South Maitland, Nova Scotia have been reported by Charbonneau and Ford'.(Charbonneau and Ford 1979)

In the present area, brecciaed Sandstone and limestones seems to be probable host for uranium deposits.

Sandstone-hosted uranium deposits in paleo valleys and paleo channels in the 'Lake Frome' region (Australia) and Mountain Valley and White Canyon districts (USA), commonly localized at the confluences and intersections of channels and/or near bends. Probably, the location of deposits at these sites is caused by several inter-related factors such as the presence of basement scours, predominance of coarse-grained sediments, and abundance of organic material. (S. Jaireth, J. Clarke and Andrew Cross., 2010)

Uranium minerals, Uraninite and Coffinite, from high-grade ore samples (U_3O_8N0.3%) in the Wuyiyi, Wuyier, and Wuyisan sandstone-hosted roll-front uranium deposits, Xinjiang, north western China were biogenically precipitated and psuedomorphically replace fungi and bacteria.(Maozhong ,*,Huifang, ,Jia & ,Mostafa,20050.

D. Rocks Of Mizoram Vis A Vis Uranium Mineralization

The Tripura Mizoram basin is the southern extension of the Surma Valley and forms a part of the Assam- Arakan basin. Palaeogene and Neogene sediments were filled into mobile geosynclinal trough and deformation of that basinal prism was brought about by both horizontal compression as well as vertical movement. The transportation direction is deduced from paleocurrents structures and the palaeoslope can be determined by the slump fold axis orientation and the facies gradients are parallel to the longitudinal axis of the basin (Sarkar and Nandi, 1977).

The Tipam Group is exposed only in the northeastern part of Mizoram, while the Barail sediments are available in the eastern part. The rest of the area is covered by Surma Group of sediments and shales. These beds contain organic matter in sufficiently huge quantity and also the fossil and Central Myanmar basins resemble close connection between the two during the Neogene times (Das Gupta, 1982). The following are the observed evidences favorable for the uranium mineralization in the Surmas.

The higher concentration of $Radon^{222}$ in the soils and vegetables of the neighboring states of northeastern India, such as 0.25 ppm in cereals, 0.44 in fruits, 0.77 ppm in leafs and 2.67 ppm in soils (Kumar and Verma, 2005). Similar evidences have been found from the Devon and Nottingham, UK where the Radon concentration is found to be high in the soil/soil gas. Uranium is weathered easily from the host rock by the deep weathering action from the water available in the underlying permeable strata, yielding the host rock high in radium(immediate precursor of radon).The radon is easily emanated from the host rocks very easily rendering a higher radon content (Ball and Miles 1992).

Mogak Group consisting of Gneisses, schists, and Kalibag Granites are exposed in the northern Myanmar, which may be the source region of these Uraniferous sediments.

The various primary sedimentary structures characterizing the Surma sediments are indicative of shallow marine to deltaic environment of deposition with a constant south worthy palaeoslope (Sarkar and Nandi, op. cit.).

E. Geochemical Imprints

The Chemical analysis of major and minor element have been performed on X-R-F in oxide percentages and presented in the Table – 4. The Trace elements in parts per million were also determined and presented in the same Table i.e. Table – 4. The weight percentages of Major/Minor elements are presented in Table – 5.

F. Discussion

Prominent important information is exhibited in (Fig.1) i.e. a persistently higher amount of (>4 ppm) uranium in the rocks of Middle Bhuban rocks in the Study Area Further, it is relatively low in Shales as compared to Sandstones. Thorium also follows a similar trend, but values are more as compared to uranium. Again 'Pb' and 'Ga' are also having higher values where uranium and thorium are higher.

Fig.2 shows the U/Th ratio of the rocks of study area. The average U/Th is 0.202**.**

The average U/Th ratio (0.202) is plotted in the pH-Eh Diagram (Ryzhenko, N. and Vernadsky, 2006) to determine the average Eh/pH ratio for the rocks of the study area (Fig.3). The Eh/pH ratio determined in the Fig.3 is thus plotted in Fig.4 for the range of naturally occurring Eh/pH conditions. The figure clearly explains that according to the range of Eh (0,40) and clearly exhibit that the rocks of the study area, fall in Category the stability field of UO_2 in reducing environment or USO_4 (*https://www.slideshare.net/hzharraz/uranium-ore-deposits*). Reducing environment condition is very much favorable for uranium mineralization at higher depths.

In the study area, presence of carbonaceous shales with fossil wood and clay balls is suggestive of strong reducing conditions at the time of deposition. Analogous deposits have been found in the Kootznahu Formation of Southern Alaska where the uranium mineralization is associated with the radioactive carbonaceous wood fragments. Susan et al., 2016 have also found similar evidence of uranium mobility in organic rich sediments. Further the Eh - pH ration of the rocks of the study area falls in the zone of anaerobic and stagnant water condition, as expressed in Fig.5 (after Macpherson, and Townsend, 2013).

This inference is further supported by the thickly bedded sandstones, which is exhibiting gray colour at places due to the presence of carbonaceous matter and also containing organic matter in it. So, in the deeper depth in the reducing environment, the probable mineral phase is Uraninite (UO_2) and in the sub surface oxidizing environment it may be Coffinite (USO_4).

The heavy mineral assemblage in the Surma sediments suggests a mixed provenance of acid igneous rocks and high grade metamorphic rocks. The varying range of Cr/Ni ratio from 4-11 from the samples of study area, is further suggestive of mixed provenance. (Fig.6).

G. Concluding Remarks

Thickly bedded sandstones and shales of the Surma Group are widely exposed in the state of Mizoram. The lower and Middle part of the groups seems to be most probable host rock for uranium mineralization. Considering the reducing environment, the probable mineral phase is Uraninite (UO_2), in the study area.

For further exploratory programme, a more sensitive technique is desirable, since the mineralization is expected at relatively greater depth and the radiations which are reaching to the surface may not be as strong as that of a near surface uranium deposits.

REFERENCES

[1] Anderson E.B., Ivanov P.A. & Komínek J., 1988. Intra-ore metasomatism within uranium veins of the Rozna deposit. Geol.Hydromet. Uranu, 12: 70–89. (In Czech).Czechoslovak Uranium Industry, 1984. Czechoslovak uranium deposits. 386 pp., SNTL. Praha. (In Czech).

[2] Basilevsky, A. T. Ryzhenko, B. N. and Abdrakhimov A. M. (2006). Differentiantial mobility of uranium and thorium in aqueous solutions as potential indicator of past geochemical environment on mars; Martian Sulfates as Recorders of Atmospheric-Fluid-Rock Interactions), p 7031.

[3] Bodnar R.J., Reynolds T.J. & Kuehn C.A., 1985. Fluid-inclusion systematics in epithermal systems. In: Berger B.R.,

[4] Bethke P.M. (eds.), Geology and Geochemistry of Epithermal Systems. Soc. of Econ. Geol., Reviews in Econ. Geol., 2

[5] Bowai, S.H.U (1970) Inversion in "Uranium Exploration Geology" I.A.E.A., Viena, pp 265-300.

[6] Chaodhary, S. and Goswamy, T.D. (1991) Estimate of Uranium in some edible and commercial plants; Seventh National Seminar or Particle Tracks in Solids (Application to Environmental Monitoring) during Oct. 9-11, 1991, Defense Laboratory, Jodhpur, Abs. P. 7 NCPTS-50.

[7] Charbonneau, B.W. and Ford' K.L. (1979) Discovery of two Uranium Occurrences in Paleozoic Sedimentary Rocks at South March, Ontario and South Maitland, Nova Scotia by Airborne Gamma-Ray Spectrometry and Comparison with Survey over Precambrian terrain.,Jour.Geol. Survey of Canada. Pp 54-76.
[8] Das Gupta, S. (1982) Synthesis and Faunal records from the Surma Basin Rec. Geol. Surv. Ind. Vol.112, pt IV, pp 31-38.
[9] Detecting / Mapping Deep-Seated Athabasca Conductors and Alteration Haloes Using Airborne EM, Gravity Gradiometer Surveys and D.C. Resistivity Techniques for Uranium Exploration. Koch R., COGEMA Resources Inc, Saskatoon, Canada McGowan P., UEX Corporation, Vancouver, Canada
[10] Finch, W.I. et al., (1973) Nuclear Fuels, IN Brobst, D.A. and Pratt, W.P. (Eds.) United States Mineral Resources, USGS Proof paper no.820.
[11] Ganju, J.L.,(1975) Geology of Misogamy., Bull, Geol. Min.Met. Soc. India No. 48, pp 17-26.
[12] G.S.I.(1974) Geology and Mineral Resources of the states of India. Mis. Pub. Geol. Surv. Ind. No.30, pt IV, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, pp 93-101.
[13] Hájek A., Uhlík Z., Bajer B., Rozhon V. & Vokoun J., (1984). Final report on the uranium reserves of the Rožná deposit. Czechoslovak Uranium Industry Exploration Division Report CR 820, 280 pp. (in Czech).
[14] Harraz, H.Z. (2013): https://www.slideshare.net/hzharraz/uranium-ore-deposits
[15] Ibrahim, M.E, Saleh,G.M. and Ibrahim,W.S.(2010) Low Grade Metamorphosed Sandstone –Type Uranium Deposits,Wadi Sikait, South Eastern Desert, Egypt, Jour. Geology and Mining Research Vol.2(6),pp 129-141,Nov.2010.
[16] Johan Ram and Venkatraman, B. (1984) Tectonic Framework and Hydrocarbon Prospects of Mizoram, Proc. Symp.Petroliferous Basins of India, Petro.Asia Jour. Vol.2, pp 60-65.
[17] Keller, E.A. (1985) Environmental Geology. 4th Edition, Charles E. Merril Publ. Co. Ohio 43216. European Current Research On Fluid Inclusions, Porto 2001Abstracts (Eds. F. Noronha, A. Dória and A. Guedes) Faculdade de Ciências do Porto, Departamento de Geologia, Memória nº 7, pp. 115-117. Porto, 2001
[18] Kribek B., Hladíková J., Zák K., Pudilová M. & Uhlík Z., 1996. Barite-hyalophane sulfidic ores at Rozná, Bohemianmassif: Czech Republic: Metamorphosed black shale-hosted submarine exhalative mineralization. Economic Geology, 91: 14–35.
[19] Lambert, I., McKay, A., and Miezitis, Y. (1996) Australia's uranium resources: trends, global comparisons and new developments, Bureau of Resource Sciences, Canberra, with their later paper: Australia's Uranium Resources and Production in a World Context, ANA Conference October 2001.
[20] Maozhong Mina, B, *, Huifang Xuc ,Jia Chena and ,Mostafa Fayekd (2005): Evidence of uranium biomineralization in sandstone-hosted roll-front uranium deposits, Northwestern China, OreGeologyReviews26(2005)198–206., pp 198-206. Elsevier.www.elsevier.com/locate/oregeorev.
[21] Macpherson, G.L. and Townsend, M.A. (2013): Water Chemistry and Suitable Yield, 116, Bulletin 239, Chapter 5, pp.117-154.
[22] Qureshi, A.A., Samad Beg, N.A.; Ahmed F. and Khan H.A. (1988) Uranium Exploration in Pakistan using Alpha Sensitive Plastic Films (ASPF); Neuclr. Tracks Radiant. Mis. Vol. 15, No.1-4, pp 735-739.
[23] Ryzhenko, N. and Vernadsky, A. M. A (2006) Martian Sulfates as Recorders of Atmospheric-Fluid-Rock Interactions p. 7031
[24] Sarkar, K. and Nandi, D.R.(1977) Structures and Tectonics of Tripura-Mizoram Area, India, Mis. Pub. Geol. Soc. India. Pt.1, No.34, pp 141-148.
[25] Shiva Kumar and Verma, R. (2005) Prospect of Uranium Mineralization in Mizoram State: An Appraisal. GEOGRAPHIC, ISBN.No. 0975 4121. Journal Dept. Of Geography, Mizoram University. pp. 37-43
[26] Smirnov, V.I.(1983) Studies of Mineral Deposits (Ed.) Mir Publ., Moscow, p 238.
[27] Subhash Jaireth, Jon Clarke and Andrew Cross(2010)Exploring for sandstone-hosted uranium deposits in paleo valleys and paleo channels, Aus. Geo News, Jour. Geoscience Australia, issue 97 Mar 2010, pp 1-5.
[28] Susan, A. Cumberland, Grant Douglus Kliti Grice and Moreau, John, W. (2016): Uranium Mobility in Organic Matter Rich Sediments: A Review of Geological and Geochemical Rich Process, Earth Science Review, 169 216, pp. 160 -185
[29] Turekian, K.(1963).Studies in Analytical Geochemistry, University of Torento Press, pp12.
[30] Vencelides Z., 1991. Sulfide and barite mineralization of the Rozna deposit. Unpublished M. Sc. thesis, Faculty of Science, Charles University. Praha. (In Czech).
[31] Vosteen Hans-Dieter & Weinoldt, 1997. Flussigkeitseinschluspetrographie und Geochemische Untersuchungen zur Entstehung der Uranlagerstatte Rozna/Tschechische Republik. Diplomarbeiten, Technischen Universitat Clausthal.Wedepohl, K. (1967).Geochemistry, Walter de Grunter & Co, Berlin, pp 134.

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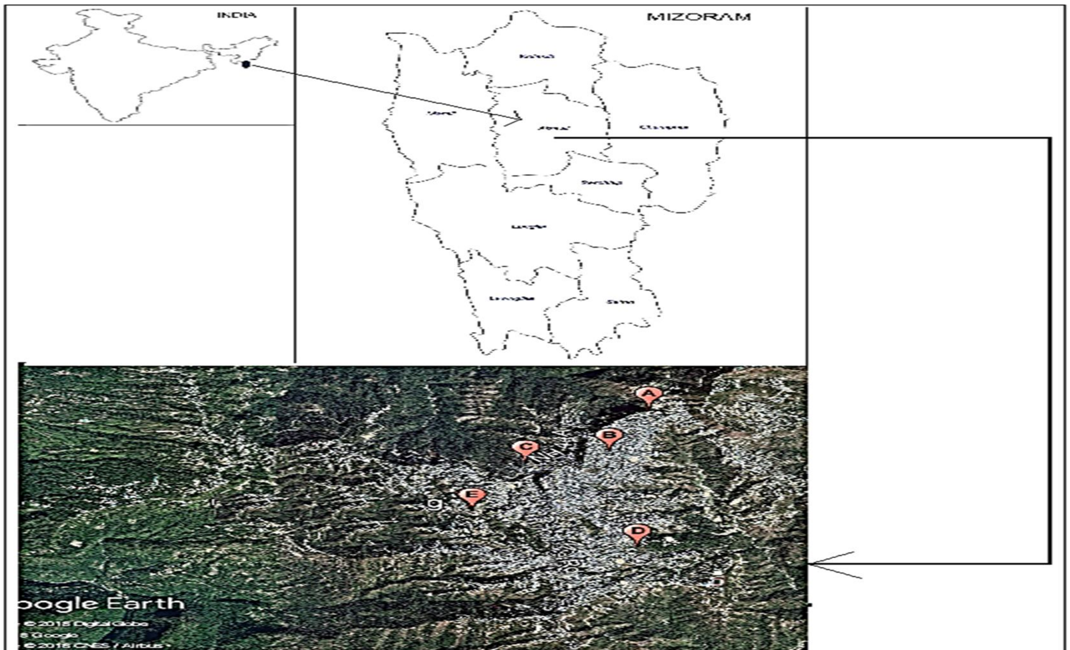
FIG.1 : LOCATION MAP OF STUDY AREA



Sample Location:
A– Chaltlang ; B – Chanmari ; C – Company Peng
D – College Veng ; E – Chawnpui

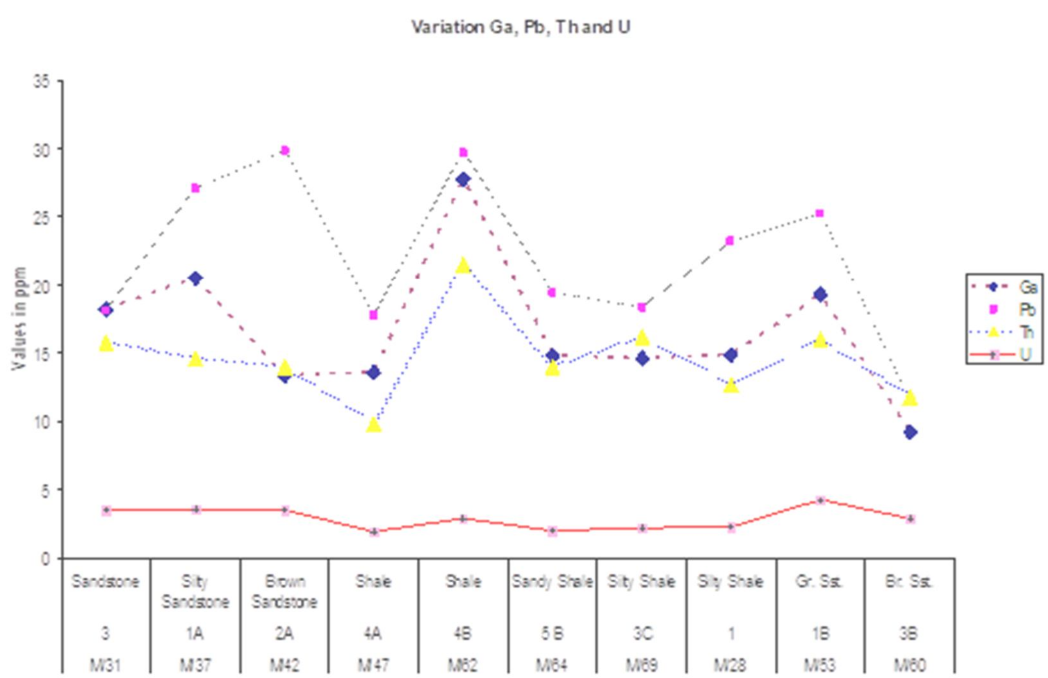


FIG.2 : VARIATION OF Ga, Pb, Th, U

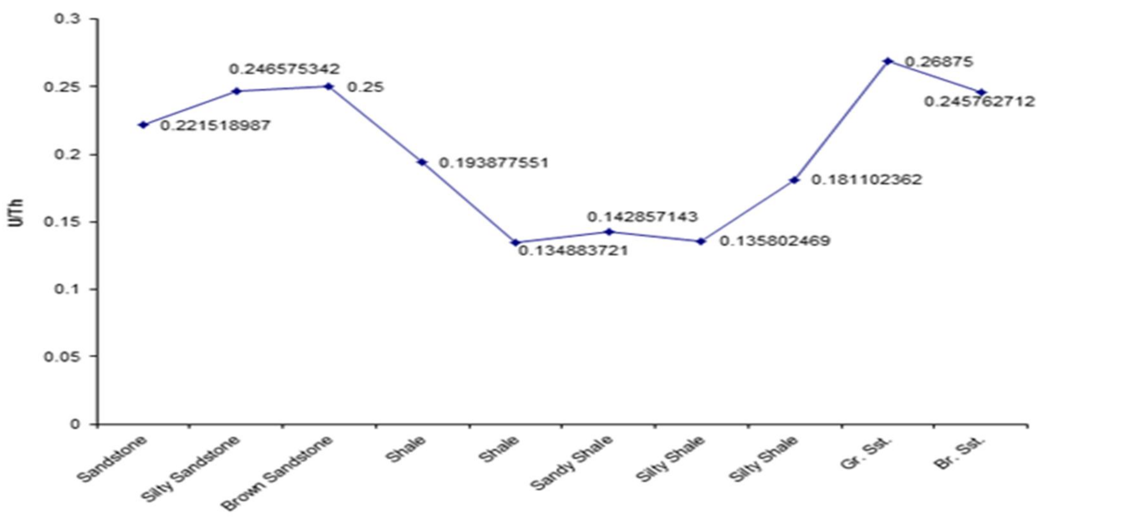
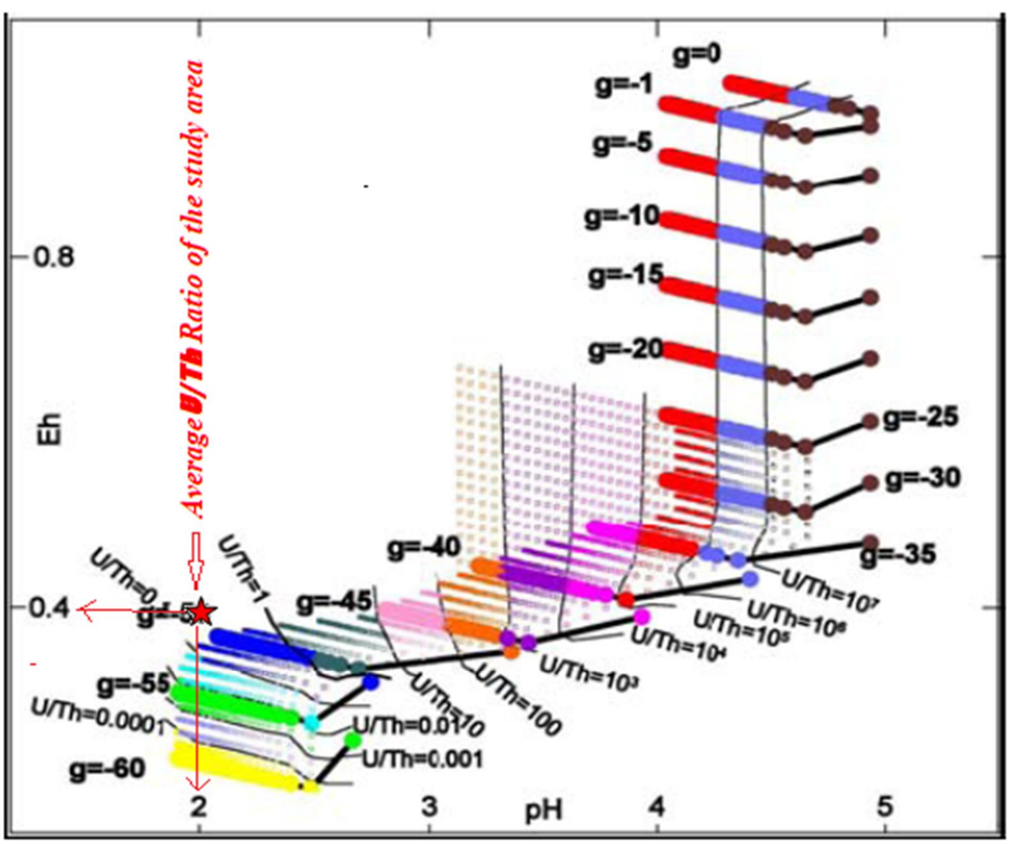


FIG.3 : U/Th RATIO OF REPRESENTATIVE SAMPES



Source (Ryzhenko, N. and Vernadsky, 2006)

★ *Average U/Th Ratio of the study area (0.202)*

FIG. 4 : U/Th RATIO PLOTTED IN THE Eh - PH FENCE DIAGRAM

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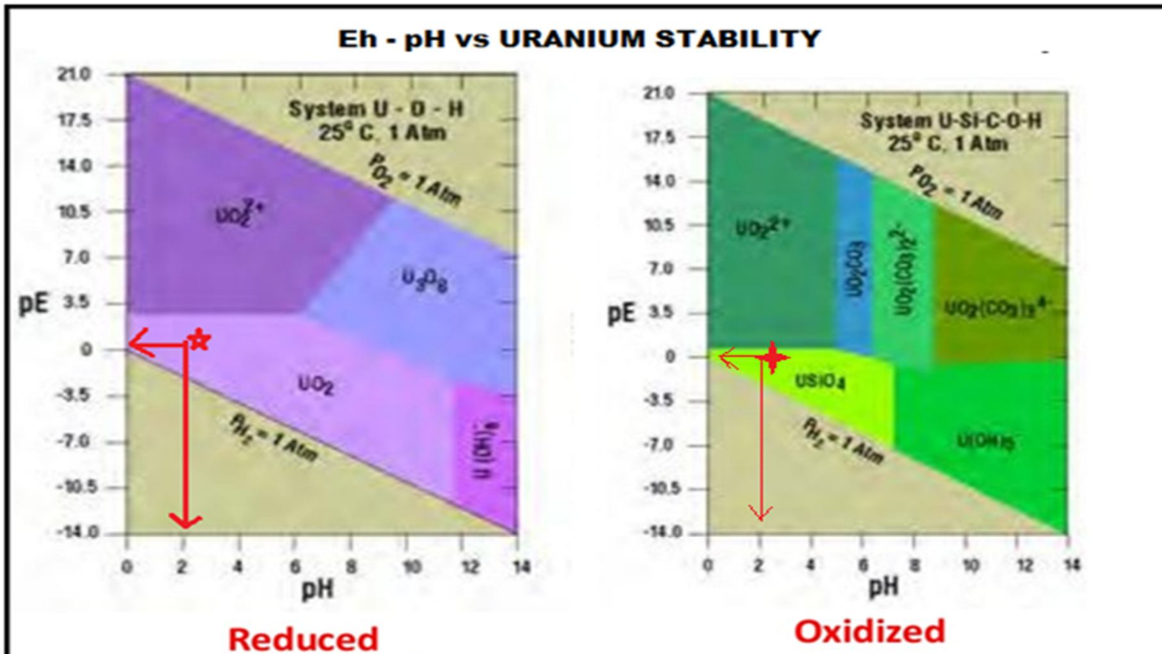
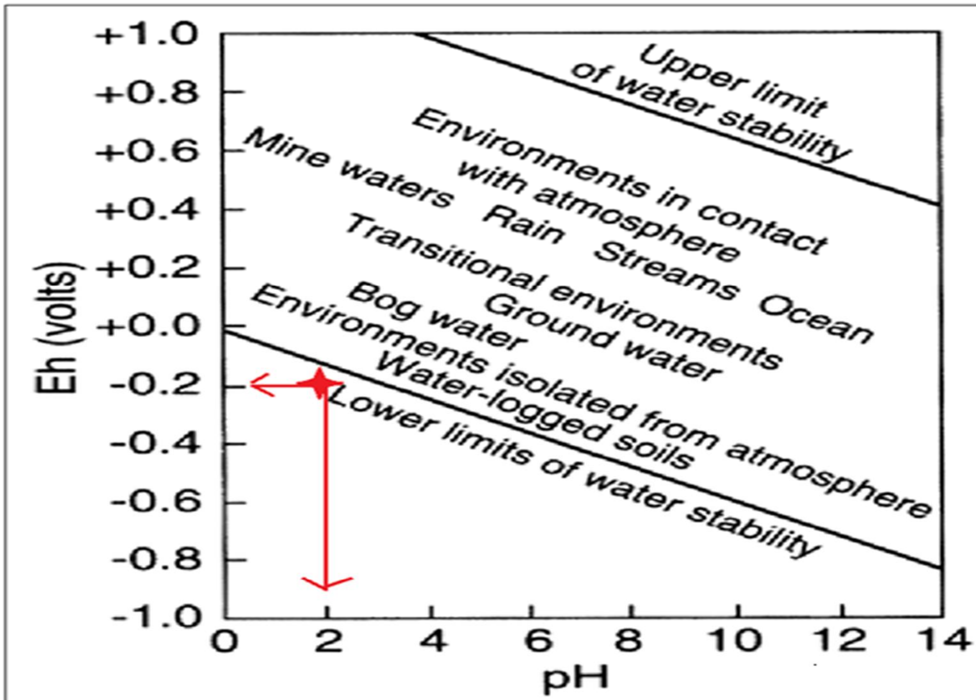


Eh - pH ratio of the study samples
(Derived from Eh-pH values range as interpreted with Fig.3 for the samples of study area)
Source:https://www.slideshare.net/hzharraz/uranium-ore-deposits

FIG.5 : Eh-pH CONDITION OF STUDY SAMPLE vs. URANIUM MINERALIZATION



Eh -pH ration of Study area samples
Source: KGS Bulletin 239, 2013 Water Chemistry and Sustainable Yield/ G. L. Macpherson[1] and M. A. Townsend[2]

FIG.6 : ENVIRONMENTAL CONDITON OF STUDY SAMPLES

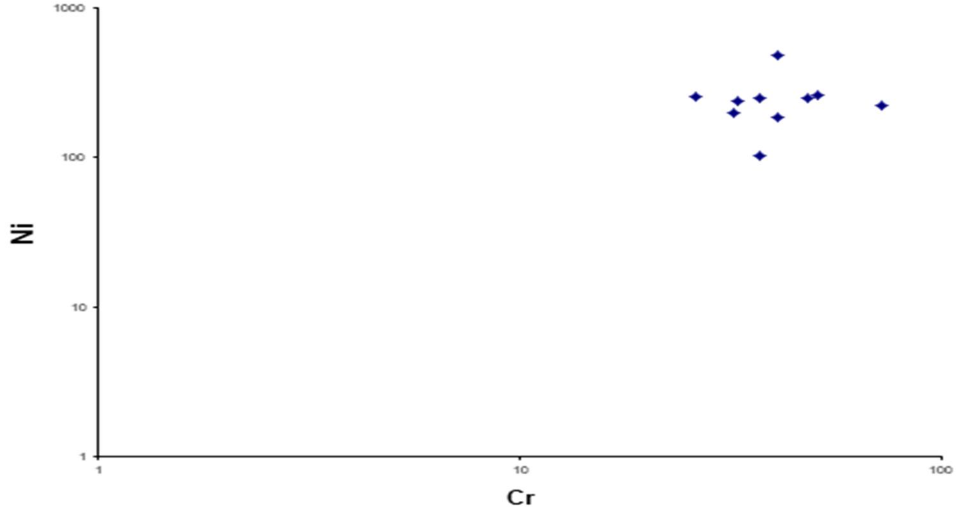


FIG.7 : PLOT SHOWING Cr - Ni RATIO

TABLE –1: MINERALS OF URANIUM

MINERAL	CHEMICAL COMPOSITION	COLOUR	SPECIFIC GRAVITY	TYPICAL OCCURRENCE
Uraninite	UO_2(Contains Th and REE)	Black	8-10.6	Arendal, Norway
Pitchbledne	UO_2	Black	6-8	Sinkolbwe, Zaire
EurexinitePolycrase	$(Y,Ca,Ce,U,Th)\ (Nb,Ta,\ Ti)_2\ O_6$	Dark Brown	4-6	Nippssiang, Ontario,
Samarskite	$(Y,Ce,Fe,U,Th)(Nb,Ta,)_2\ O_6$	Black	5-6	Mitchel Co.N.C.
Brannerite	$(Y,Ce,Fe,U,Th)(Ti,Si)_5\ O_{16}$	Black	4-5	Blind River, Ontario
Davidite	$(Fe,Cu,U)_3(Ti,Fe,V,Cr)_3(O,OH)_7$	Black	4-5	Rum Jungle, Australia
Coffinite	$USiO_4$	Black	5-6	Colarado Plateau
Carnotite	$K_2\ (UO_2)_2\ (VO_4)_2xH_2O$	Yellow	3-5	Colarado Plateau
Tyuyamunite	$Ca(UO_2)_2\ (VO_4)_2xH_2O$	Yellow	3-4	Fergnana, Turkistan
Autunite	$Ca\ (UO_2)_2\ (PO_4)_2xH_2O$	Gr.Yellow	3-4	Autun, France
Tobernite	$Cu(UO_2)_2\ (PO_4)_2xH_2O$	Yellow	3-4	Erzgebirge, Saxony
Uranophane	$Ca\ (UO_2)_2\ (Si_2O_7)xH_2O$	Gr.Yellow	3-4	Congo Republic

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TABLE 2. GENERALIZED GEOLOGICAL SUCCESSION OF MIZORAM (After Ganju,1975)

AGE	GROUP	SUBGROUP	FORMATION	GENERALISED LITHOLOGY
Recent	Alluvium			Silt, Clay and Gravel
		~~~Unconformity~~~		
Early Pliocene to Late Miocene	Tipam (+ 900 mts)			Friable Sandstones with occasional clay bands
		Conformable and transitional contact		
Miocene To Late Oligocene	SURMA (+5950m)	BOKABIL		Shale,Siltstone and Sandstone
			Conformable and transitional contact	
		BHUBAN	Upper Bhuban (+110 mts)	Arenaceous predominating with sandstone, shales and siltstone
			Conformable and transitional contact	
			Middle Bhuban	Argillaceous predominating with shale, siltstone-shale alternations and sandstone
			Conformable and transitional contact	
			Lower Bhuban (+900m)	Arenaceous predominating with sandstone and silty-shale
		~~~Unconformity obliterated by faults~~~		
Oligocene	BARAIL (+3000m)			Shale, siltstone and sandstone
		Lower contact not seen		

TABLE – 3: CHEMICAL ANALYSIS OF LOWER AND MIDDLE BHUBAN ROCKS

MAJOR & MINOR OXIDES (in %)

OXIDES in %tage.	**M/31 3**	**M/37 1A**	**M/42 2A**	**M/47 4A**	**M/62 4B**
ROCK TYPE	Sandstone	Silty Sandstone	Brown Sandstone	Shale	Shale
Locality	Chanmari-Chaltlang	Chawnpui	Chawnpui	Chawnpui	Company Peng
SiO_2	68.35	64.32	72.56	71.83	59.46
TiO_2	0.69	0.68	0.67	0.61	0.81
Al_2O_3	15.38	16.76	13.72	13.54	20.30
Fe_2O_3	5.65	6.38	3.84	4.62	6.07
FeO	-	-	-	-	-
CaO	0.33	0.31	0.21	0.45	0.27
MgO	1.54	2.00	1.23	1.79	1.98
MnO	0.038	0.152	0.033	0.088	0.039
Na_2O	1.54	1.22	1.15	1.91	1.05
K_2O	2.48	3.10	2.18	2.26	3.66
P_2O_5	0.105	0.100	0.098	0.101	0.103
Total	96.08	95.03	95.69	97.21	93.75
LOI %	4.59	5.1	3.44	3.81	6.27

TRACE ELEMENTS (in ppm)

ELEMENT (ppm)	**M/31 3**	**M/37 1A**	**M/42 2A**	**M/47 4A**	**M/62 4B**
Sc	12	12	8	7	14
Co	14	19	8	15	18
Ni	37	48	32	41	72
Cu	25	29	19	23	38
Zn	80	100	254	74	113
Ga	18.2	20.5	13.4	13.6	27.8
Pb	18.1	27.1	29.8	17.8	29.7
Th	15.8	14.6	14.0	9.8	21.5
Rb	108.3	139.3	78.8	91.3	180.7
U	3.5	3.6	3.5	1.9	2.9
Sr	79	84	65	96	95
Y	34.1	**32.7**	**35.3**	21.9	38.9
Zr	238	212	413	178	230
Nb	15.7	13.9	12.2	11.1	17.3
Ba	373	527	343	337	352
Cr	103	249	197	188	223
V	89	133	87	87	90

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Table – 4: CHEMICAL ANALYSIS OF LOWER AND MIDDLE BHUBAN ROCKS

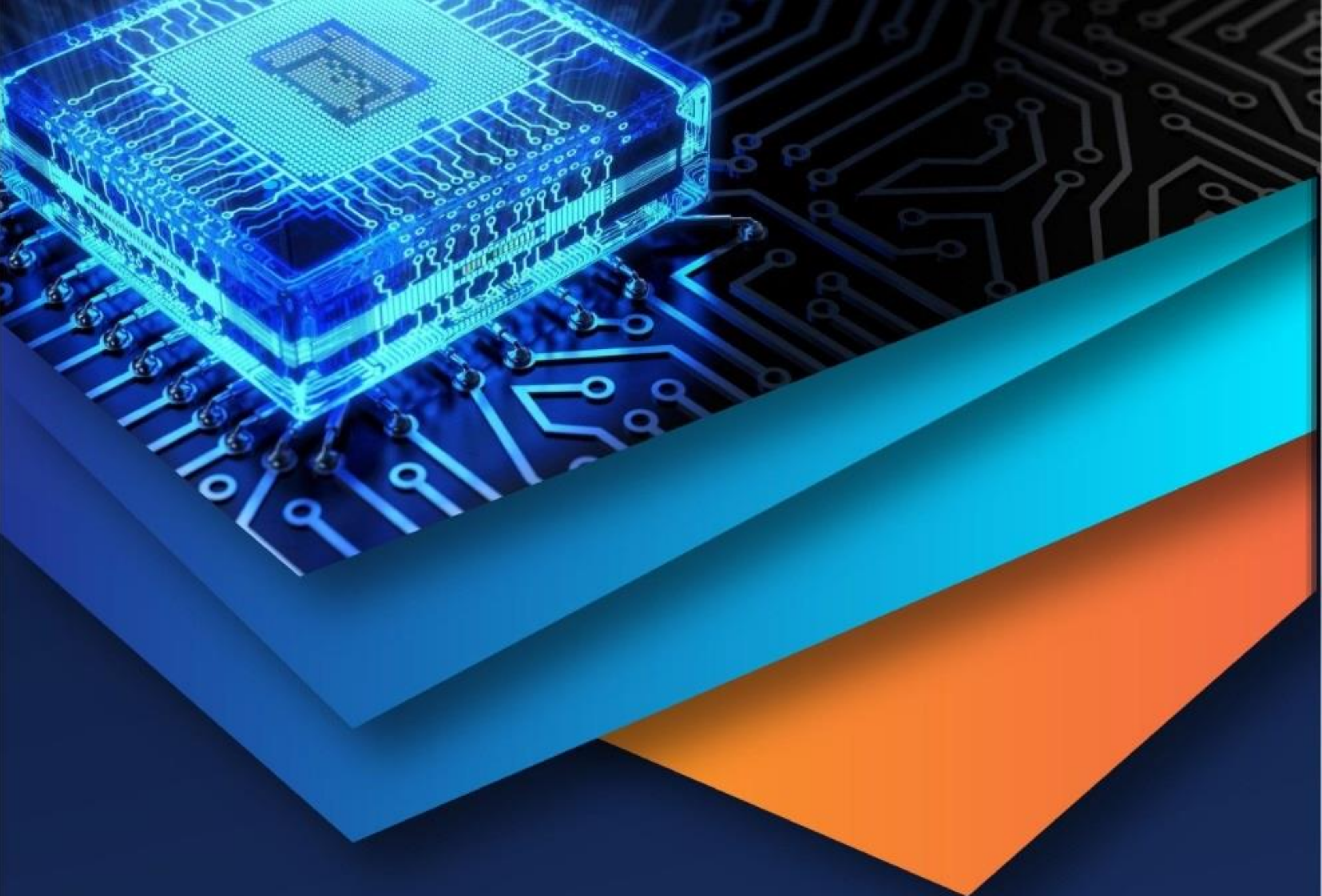
MAJOR & MINOR OXIDES (in %) Contd……

OXIDES (%)	M/64 5 B	M/69 3C	M/28 1	M/53 1B	M/60 3B
ROCK TYPE ▸	**Sandy Shale**	**Silty Shale**	**Silty Shale**	**Gr. Sst.**	**Br. Sst.**
Locality ▸	Company Peng	College Veng	Chanmari-chaltlang	Company Peng	Company Peng
SiO_2	66.02	75.62	74.45	69.14	84.15
TiO_2	0.65	0.70	0.66	0.70	0.58
Al_2O_3	13.57	11.77	13.10	15.23	7.89
Fe_2O_3	4.54	4.79	4.64	5.62	3.33
FeO	-	-	-	-	-
CaO	4.42	0.29	0.38	0.38	0.22
MgO	1.61	0.99	1.56	1.86	0.75
MnO	0.224	0.077	0.033	0.039	0.030
Na_2O	1.46	1.62	1.83	1.54	1.58
K_2O	2.61	2.08	2.09	2.90	1.46
P_2O_5	0.104	0.096	0.106	0.088	0.079
Total	95.21	98.03	98.87	97.50	100.07
LOI %	7.18	4.01	3.47	4.4	2.85

TRACE ELEMENTS (in ppm)

ELEMENT (in ppm)	M/64 5 B	M/69 3C	M/28 1	M/53 1B	M/60 3B
Sc	11	6	8	10	5
Co	13	13	11	15	9
Ni	33	37	41	51	26
Cu	22	23	23	26	17
Zn	69	66	68	85	46
Ga	14.8	14.6	14.9	19.3	9.2
Pb	19.4	18.3	23.2	25.2	11.5
Th	14.0	16.2	12.7	16.0	11.8
Rb	99.2	91.7	87.8	124.1	62.0
U	2.0	2.2	2.3	4.3	2.9
Sr	109	72	72	85	54
Y	30.1	**32.5**	30.2	30.1	27.5
Zr	255	361	293	238	326
Nb	13.6	15.8	14.2	14.7	12.8
Ba	369	309	409	313	306
Cr	239	247	483	262	254
V	101	68	97	79	77

======================END======================



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