Soil pH & Electrical Conductivity of Unconformity related Uranium mineralization in Akkavaram area, in the part of Srisailam sub basin, Nalgonda District, Andhra Pradesh (India).

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Abstract - Pedogeochemical sampling over an area of 24 Sq.Km taken up in the Akkavaram, which is in the part of Srisailam Formation NW of Cuddapah basin, to assess the soil pH and EC of the unconformity-related uranium mineralisation of the area . The area mainly consists of the basement granite, dolerite dikes, basal pebbly quartzite and intercalated shale. Pedogeochemical sampling is carried out on a grid of 1 Km x 1 Km out of 24 Sq.Km and 24 soil samples collected from - different geological - formations. It is observed that the pH is high along the unconformity where we also observe uranium mineralization, whereas EC is low. The low pH & high EC is observed in the soil samples away from the unconformity indicating mobile nature of uranium.

Keywords – Srisailam sub basin, pedogeochemistry, unconformity, uranium, pH, EC.

I. INTRODUCTION:

Akkavaram is located in the Srisailam sub basin NW of Cuddapah basin. The Srisailam sub basin is formed geologically mid to late Proterozoic in age and it is unconformably overlying the the Archean basement granite (Senthil kumar, P. et al., 2002).). The sediments are essentially arenaceous and are represented by basal pebbly quartzite, followed by a grey medium grained quartzite with grey buff coloured shale as intercalations (Jayagopal, A.V. et al., 1996)). The basement is represented by coarse to medium grained fractured granite. Srisailam sub basin and Cuddapah basin geology with known uranium mineralization (Sinha, R.M. et al., 1995). The present study area will describe soil profile, influence of unconformity related uranium on soil pH & EC of Akkavaram. Important radioactive anomalies are located in the study area and related with unconformity contact basement granitoid with the Srisailam formation, around the Akkavaram.

II. GEOLOGY

Unconformity type uranium deposits are well known for their high grade and large tonnage in the Athabasca basin of Canada and the Pine creek Geosynclines of Australia (Hoeve, J. et al., 1980). In India, consistent efforts are being made to target similar geological environs, middle Proterozoic cover sequence which overly the Archean/lower Proterozoic basement schist, gneiss and granitoid in Purana basin. The crescent shaped Cuddapah basin, covering 44,500 Sq.Km and being the second largest of the Purana basin in peninsular India is the most promising in the country (Dhana Raju, R et al., 1993). The present study area is located in northern fringe of the Srisailam sub basin in Cuddapah basin (Figure 1). Where Srisailam formation is unconformable overlies the basement granitoid (M.B. Verma et al., 2009), at places part of the cover rocks has been eroded exposing the non-conformity contact with the granitoid. The eroded parts are settled on the earth crust, in the process of weathering and erosion whiles the sedimentation of the soil. Due to this reason the soil surface have the radiogenic materials may be present in that area. The radiometric surveys has been proved soil surface having uraniferous occurrences in such area. While the process of soil formation the uraniferous substances were melted and particles were include with in the soil, such type of soil particles may be contaminated and show the influence on the pH & EC. The research is going on the influence of unconformity related uranium mineralization on soil pH & EC.

A. Soil profile in the study area:

Soil profile varies in make- up within wide limits according to their genetic and geographic environment. Most well developed profiles however can be divided into four principal horizons are designated into A, B, C and R in descending order (Levinson, A. 1980). Further division of each layer into sub horizon differs in composition, texture, color and layer boundaries are transitional over 2.5 to 15 cm (Chaudary, M.A. et al., 2002). the A and B horizons together constitute the solum (or) true soil, while the C-horizon is the partly weathered parent material from which the solum has been transported by soil forming process.

A-Horizon nearly contains pure organic matter steady decrease in the organic matter with depth through soil profile in the study area. The A horizon undergoes extensive leaching, which removes soluble mineral salts and colloidal to lower horizon (Nohon, D.B. 1991). The A horizon contains carbonic acid and other organic acids. From the A horizon (pH range is 2.62 – 6.2 in the study area) acid moves downward, where they react with and carry the solution, suspension or colloidal form, a variety of cations and compounds. The subdivision of the A horizon occurs under a variety conditions; hence sampling of A horizon must be avoided.

The leached material transported from A horizon accumulates at B - Horizon alluvial here. This horizon has a prismatic or blocky structure that is caused by high concentration of iron and aluminum oxides in the association with organic matters and manganese oxides in the study area, a well drain soil allows removed of many of soluble compounds and elements that have been leached from A horizon. The B horizon is layer of the profile that is usually sampled for exploration for mineral deposits. The soil horizon is not well matured in the study area; B horizon is not developed and not differentiated from C (figure 2).

The C- Horizon consist more or less weathered parent material for the overlying A and B horizons. The C horizon have weathered bedrock base of the soil profile. It is important to appreciate that the parent material may be rock, transported alluvial, glacial or windblown or even soil of past pedogeochemical cycle in the study area. R – Horizon is the underlying rock material, it is unaltered bed rock.

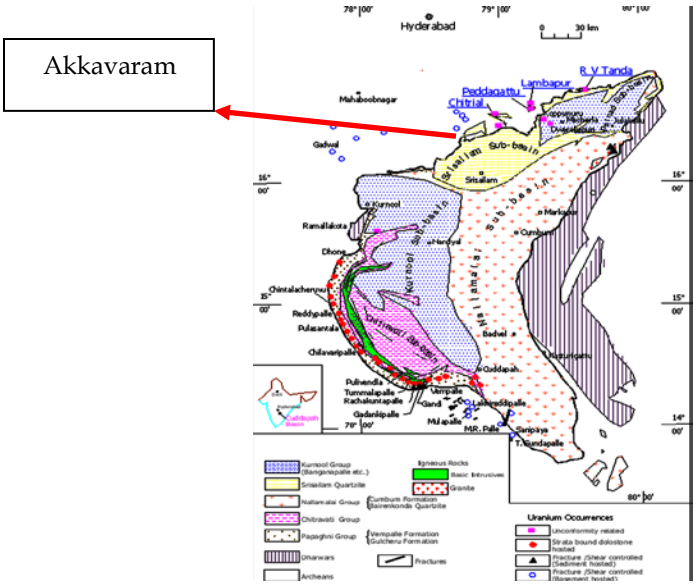

Fig 1. Location of Akkavaram in Cuddapah basin

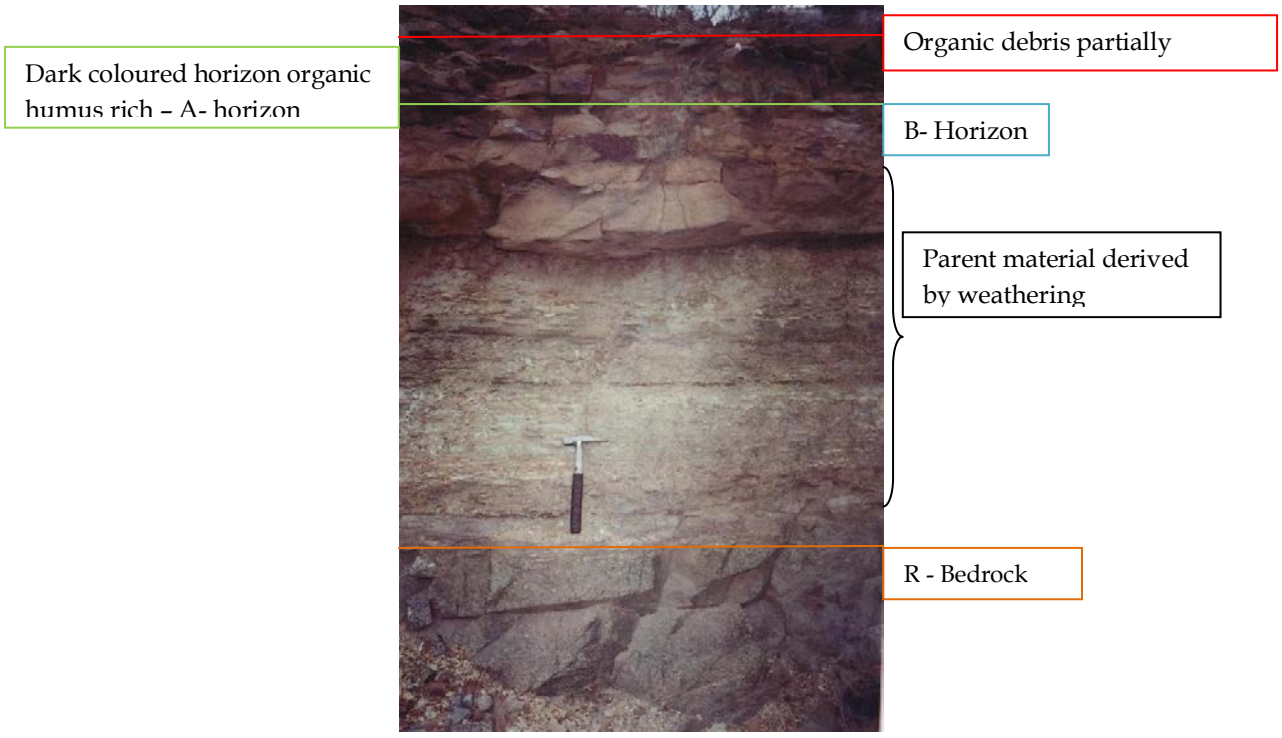

Fig 2. Soil profile of the Akkavaram

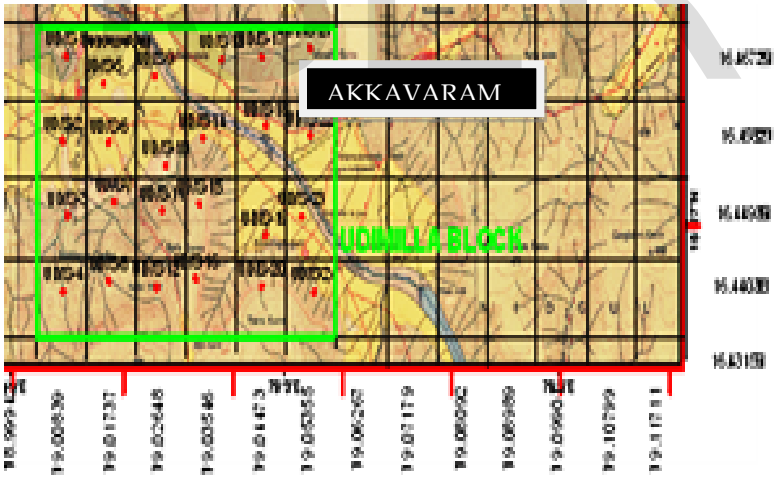

Fig 3. Soil sampling at Akkavaram

B. Materials and Methods:

Akkavaram is a part Srisailam sub basin in the North West fringe of Cuddapah basin. The area related to agriculture fields and natural biodiversity. Pedogeochemical survey was conducted about 24 Sq.Km. as per grid plan, 24 samples were collected with GPS locations under different geological conditions. Basement granite, Dolerite dykes and quartzites are the predominant of the locations. The pedogeochemical sampling is carried out 1 Sq.Km X 1 Sq.Km. according to grid plan (figure 3); samples collected from the middle of grid except in valley portions. The B - horizon is not well developed in the study area, instead of immature samples the termite mounds were

collected (Chaudary, M.A., et al 2002). The pedogeochemical samples were collected from B horizon only (Levinson, 1980). The samples were sundried and sieved -80 mesh size in the field itself to save the time and avoid the contamination. pH and Electrical Conductivity were determined with the help of digital portable analyzer kit , made by Systronics India, model 365 (Gardener, C.M.K. et al ., 1991). The samples were coning and quartering for the chemical analysis by the ICP-MS (Balaram et al., 2003).

Table no. 1. Pedogeochemical analysis results of Akkavaram

sample no	PH	EC µs/ cm	V	Cr	Co	Ni	Cu	Zn	As	Pb	Th	U
UD/S-1	6.2	744.74	0.00	20.22	21.47	24.81	12.39	31.98	1.17	13.54	1.51	1.72
UD/S-2	5.95	707.50	111.12	31.41	61.34	64.37	29.39	81.51	1.12	27.69	32.37	19.95
UD/S-3	3.3	404.29	91.34	29.55	24.34	25.55	10.65	40.01	1.45	28.22	7.97	24.41
UD/S-4	2.9	307.61	99.60	43.47	32.02	50.28	30.35	109.24	1.32	35.75	0.00	30.95
UD/S-5	3.2	382.43	55.19	13.24	17.63	17.61	9.53	12.03	1.93	11.83	7.61	6.98
UD/S-6	5	393.06	84.71	26.91	25.08	28.10	16.05	95.72	1.61	872.51	48.35	24.47
UD/S-7	2.62	428.79	47.12	20.11	19.96	14.72	9.07	20.98	1.26	8.94	1.33	1.08
UD/S-8	2.84	248.25	95.79	24.96	28.74	22.45	21.25	15.72	1.28	16.27	1.73	1.60
UD/S-9	4.4	786.11	82.99	47.75	33.84	36.46	14.64	44.49	1.31	19.72	10.18	7.78
UD/S-10	4.63	786.11	61.49	22.25	26.82	24.20	13.19	23.71	1.22	14.07	6.72	3.47
UD/S-11	5.57	707.50	56.06	15.98	21.53	20.13	14.14	35.43	1.53	33.72	3.97	20.89
UD/S-12	5.19	744.74	61.37	15.98	24.62	26.12	16.95	15.67	1.18	15.67	0.62	8.93
UD/S-13	5.05	786.11	57.22	19.60	20.63	18.31	13.69	25.75	1.21	20.13	2.92	4.75
UD/S-14	5.43	707.50	49.38	13.42	20.33	20.54	15.18	37.28	1.44	25.40	3.99	21.34
UD/S-15	5.02	832.35	149.06	23.98	38.32	34.77	31.35	32.35	1.13	10.39	4.80	2.62
UD/S-16	5.27	744.74	131.32	31.13	33.53	38.35	26.34	17.13	1.23	16.84	4.26	2.04
UD/S-17	5.4	786.11	39.04	9.78	21.18	13.49	7.65	8.74	1.23	9.80	3.56	1.90
UD/S-18	5.45	832.35	74.38	16.80	19.42	26.67	12.11	26.85	1.39	15.94	2.73	6.14
UD/S-19	5.7	832.35	71.04	20.00	17.74	23.41	15.95	34.55	1.32	22.00	4.86	3.34
UD/S-20	5.84	832.35	153.24	44.00	28.93	27.39	20.35	13.90	1.44	19.21	4.91	1.10
UD/S-21	5.15	786.11	111.58	31.21	20.17	17.32	14.10	21.53	1.79	14.54	1.11	1.62
UD/S-22	5.4	832.35	73.04	17.08	25.90	16.55	15.00	52.20	1.34	23.75	3.98	7.19
UD/S-23	5.67	786.11	92.12	22.69	23.06	17.25	12.55	28.38	1.52	24.85	6.40	6.81
UD/S-24	5.85	786.11	103.33	25.46	33.14	26.20	17.52	61.59	1.55	30.15	22.73	11.76

C. Results and Discussions:

Physical parameters like pH, EC and uranium & associated elements of area is reported in Table 1. Whereas the isochemical maps will explain the concentration of pH, EC and Uranium & associated elements of the study area.

The pH concentration (fig 4) values of pedogeochemical samples of study area between 2.62 to 6.2 and the average value of 4.84. As per the United States Department of Agriculture and Natural Resources Conservation Service (2011), formally soil conservation service classifieds soil pH ranges follows as <3.5 is Ultra acid, 3.5-4.4 Extreme acid, 4.5-5.0 very strong acid, 5.1-5.5 strong acid, 5.6-6.0 moderate acid, 6.1-6.5 slight acid, 6.6-7.3 neutral, 7.4-7.8 slightly alkaline, 7.9-8.4 moderately alkaline, 8.5-9.0 strongly alkaline, >9 very strongly alkaline.

Eight samples fall in (UD/S-12,14,16,17,18,19,21,22) strong acid range, one sample (UD/S-1) fall in slightly acid range, these samples were collected from termite mounds, five samples were fall in moderate acid range, another five samples were fall in very strong acid and five samples were fall in ultra acid range.

EC concentration (fig 5) is maximum value 832.35 µs/cm, minimum value is 248.24 µs/cm and the average value is 664.08 µs/cm, as per USDA (2011) standard the permissible limit of EC value is 2320 µs/cm in soils, no one sample is exceed the permissible limit. Other elements like U, Th, Pb, Cu, Zn, Ni, V, As, Cr & Co are expressed in ppm levels. The average abundance of uranium is 1 ppm in soils, the study area consisting of U concentration (fig 6) is maximum is 30.95 ppm and minimum is 1.08 ppm, and some samples have high values compare with desirable limit. The average value of all samples 9.80 ppm. Thorium concentration (fig 7) containing the highest value is 48.38 ppm and lowest value is 0.62 ppm average value is 9.11 ppm, naturally the average abundance of thorium is 13 ppm in soils, Pb concentration (fig 8) consisting of maximum value is 872.51 ppm, minimum value is 8.94 ppm the average value is 85.09 ppm, the common abundance value is 2-200 ppm in soils. As concentration (fig 15) containing maximum value is 1.93 ppm, minimum value is 1.12 and the average value is 1.39 ppm, the permissible limit is 1-50 ppm in soils. Zn concentration (fig 9) consisting of 109.24 ppm at maximum level, 8.74 ppm is minimum and the average is 38.64 ppm. Natural abundance of Zn is present in 10-300 ppm in soils. Cu concentration (fig 12) having highest value is 31.35 ppm, the minimum value is 7.65 ppm and the average is 16.86 ppm, the permissible limit is 2-100 ppm in soils, Ni concentration (fig 10) containing maximum value is 64.37 ppm, minimum is 13.49 ppm the average value is 27.42. Co concentration (fig 14) maximum value is 61.34 ppm, the minimum value is 17.63 ppm, the average value is 26.74 the natural abundance of Co is 1- 40 ppm in soils, Vanadium (fig 11) maximum concentration value is 153 ppm, minimum is 39.04 ppm, the average value is 80.95 ppm, the permissible limit is 20-500 ppm in soils, Cr (fig 13) maximum concentration value is 47.75 ppm; minimum value is 9.78 ppm, the average value is 24.20 ppm, the permissible limit is 5-1000 ppm in soils, no sample exceeds the permissible limit.

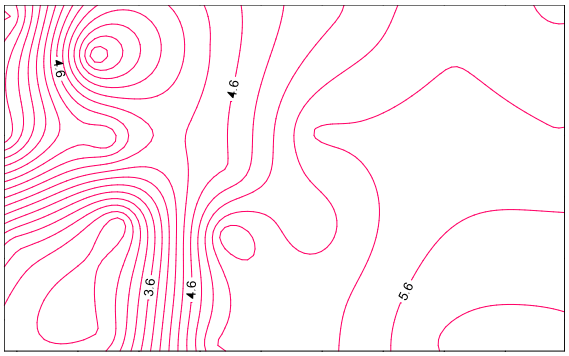

Fig 4. Concentration of pH

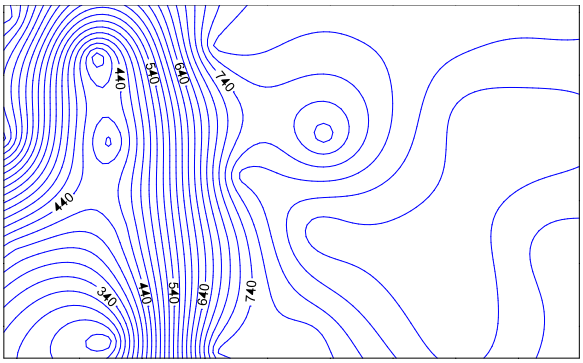

Fig 5. Concentration of EC

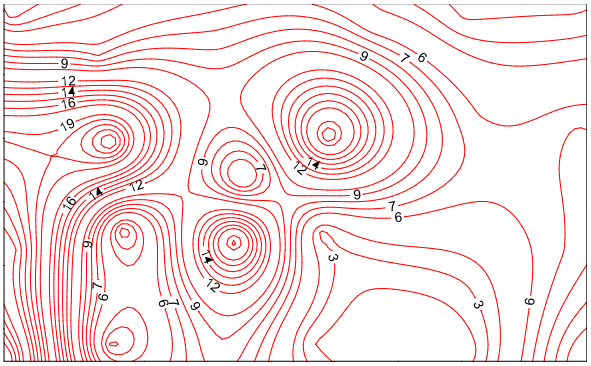

Fig 6. Concentration of U

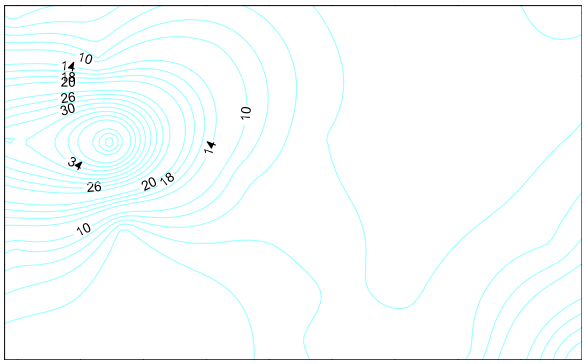

Fig 7. Concentration of Th

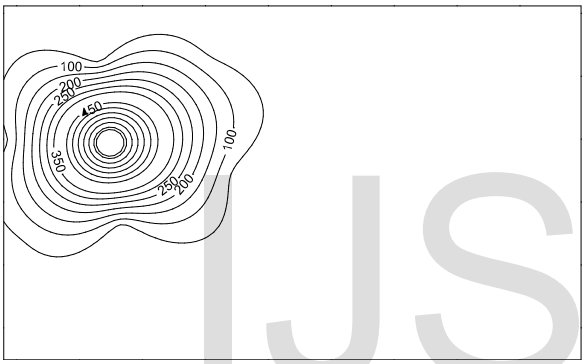

Fig 8. Concentration of Pb

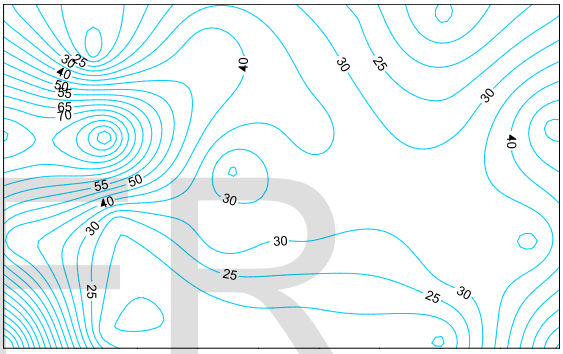

Fig 9. Concentration of Zn

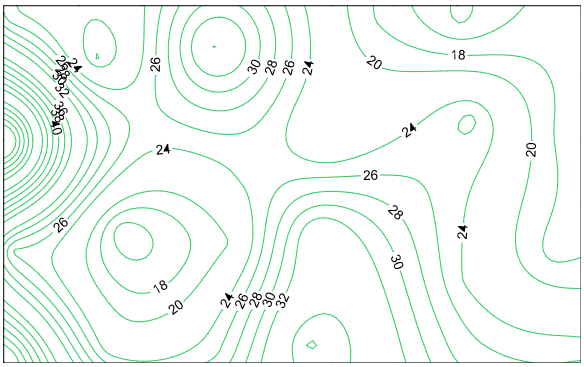

Fig 10. Concentration of Ni

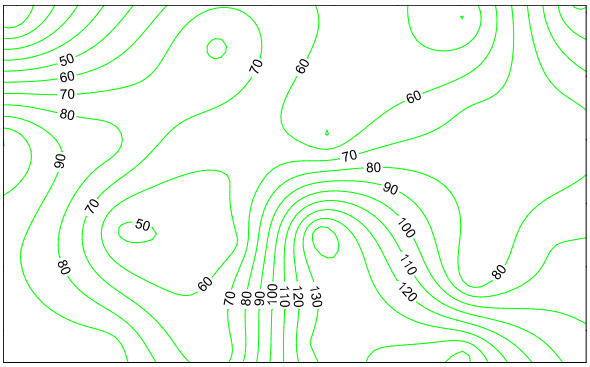

Fig 11. Concentration of V

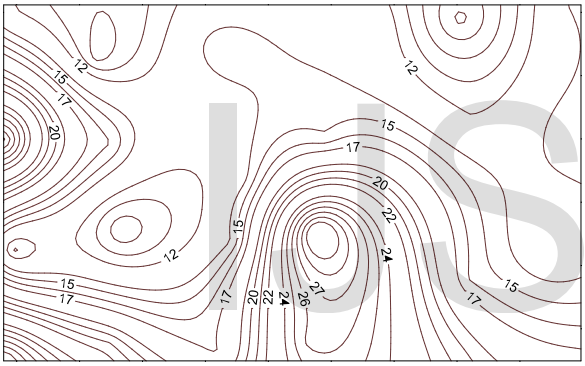

Fig 12. Concentration of Cu

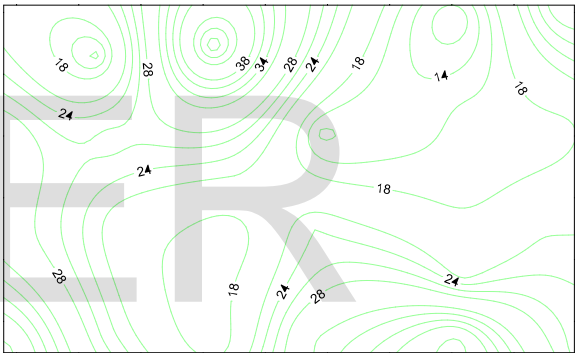

Fig 13. Concentration of Cr

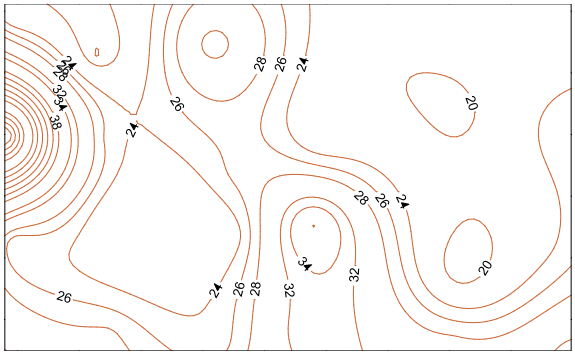

Fig 14. Concentration of Co

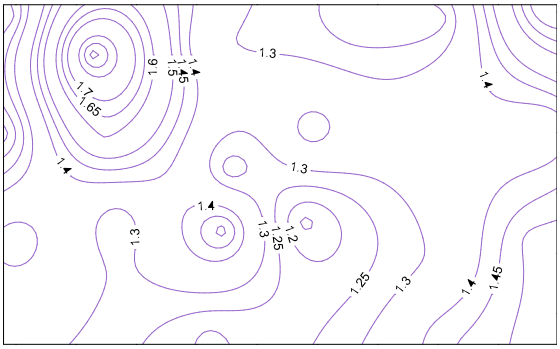

Fig 15. Concentration of As

D. Correlation of pedogeochemical parameters:

Correlation coefficient is commonly used measure to establish the relation between independent and dependent variable. The correlation matrix for 10 elements for Narayanpur area in Srisailam sub basin.

Table 2. Correlation of Uranium & associated elements of Akkavaram area.

	V	Cr	Co	Ni	Cu	Zn	As	Pb	Th	U
V	1									
Cr	**0.623**	1								
Co	0.543	0.489	1							
Ni	0.461	0.597	**0.864**	1						
Cu	**0.69**	0.502	**0.752**	**0.797**	1					
Zn	0.157	0.4	0.462	**0.617**	0.452	1				
As	0.05	-0.039	-0.409	-0.366	-0.365	-0.002	1			
Pb	0.027	0.065	-0.025	0.466	-0.007	0.505	0.251	1		
Th	0.184	0.167	0.449	0.377	0.158	**0.616**	0.171	0.776	1	
U	0.016	0.186	0.232	0.432	0.229	**0.776**	0.176	0.388	0.438	1

The above correlation matrix shows that

1. Chromium shows good correlation with Vanadium (fig 18).
2. Nickel shows better correlation with Cobalt (fig 19)
3. Copper (Cu) shows good correlation with Vanadium (fig 20), Cobalt & Nickel (fig 21 & 22).
4. Zinc shows good correlation with Nickel (fig 23)
5. Thorium shows good correlation with Zinc (fig 24).
6. Uranium shows good correlation with Zinc (fig 25)

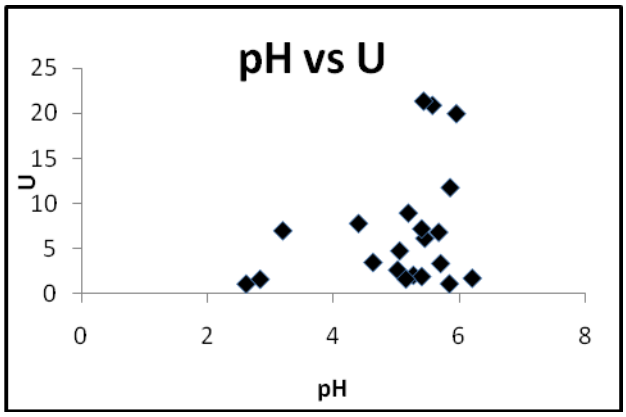

Fig 16. Concentration of pH vs U

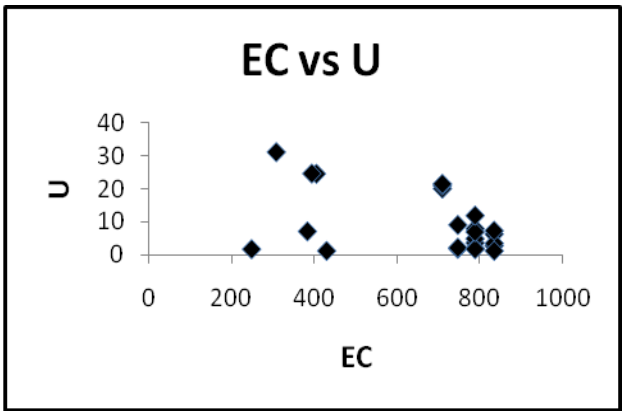

Fig 17. Concentration of Ec vs U

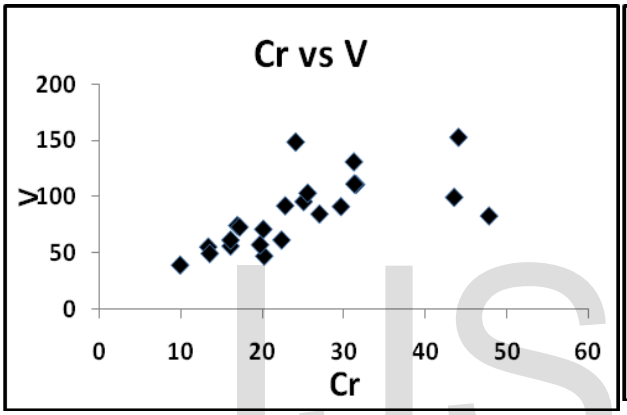

Fig 18. Concentration of Cr vs V

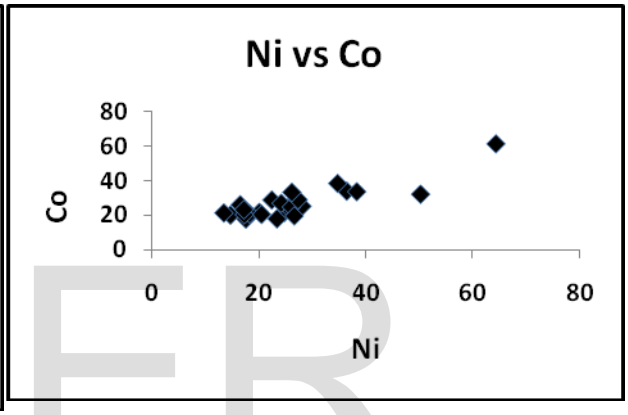

Fig 19. Concentration of Ni vs Co

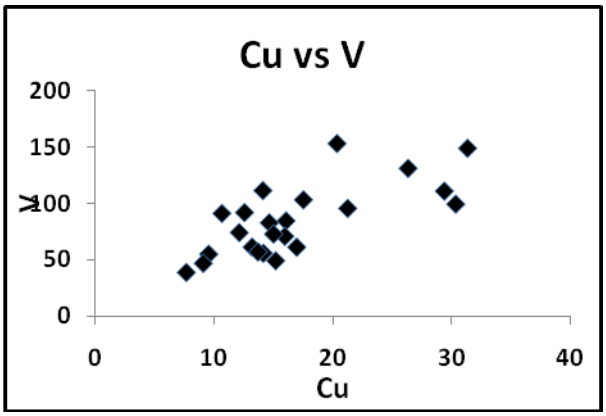

Fig 20. Concentration of Cu vs V

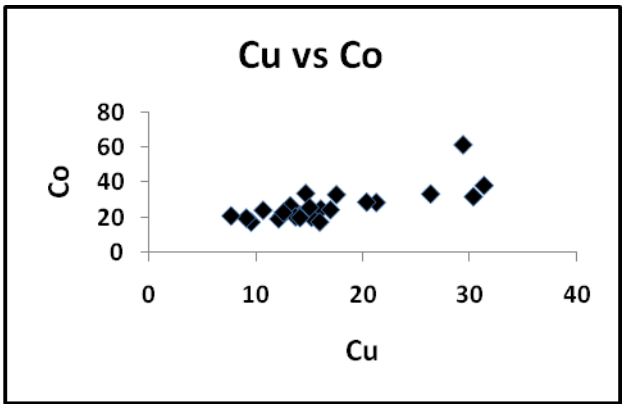

Fig 21. Concentration of Cu vs Co

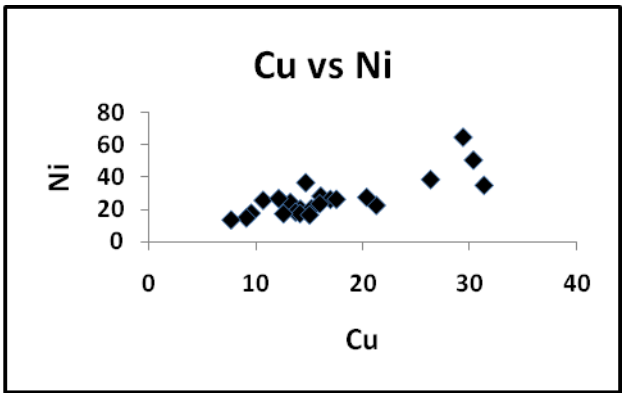

Fig 22. Concentration of Cu vs Ni

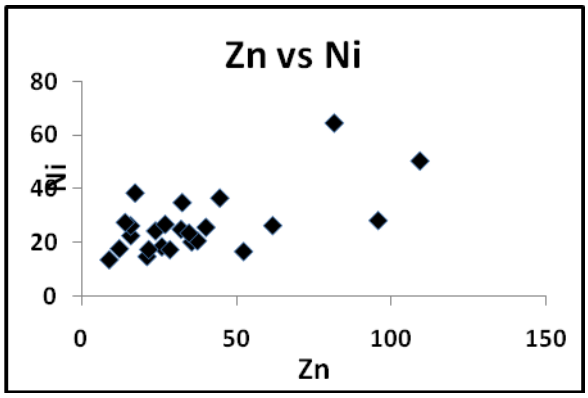

Fig 23. Concentration of Zn vs Ni

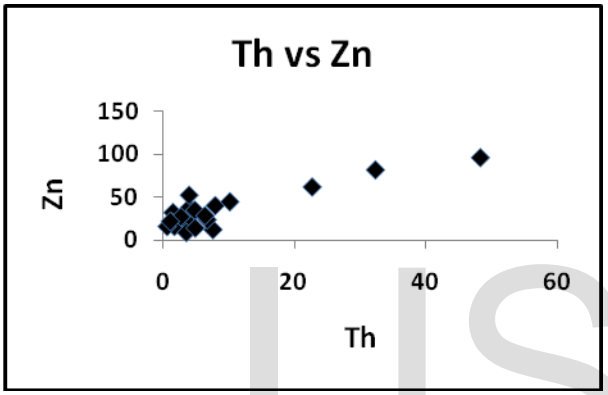

Fig 24. Concentration of Th vs Zn

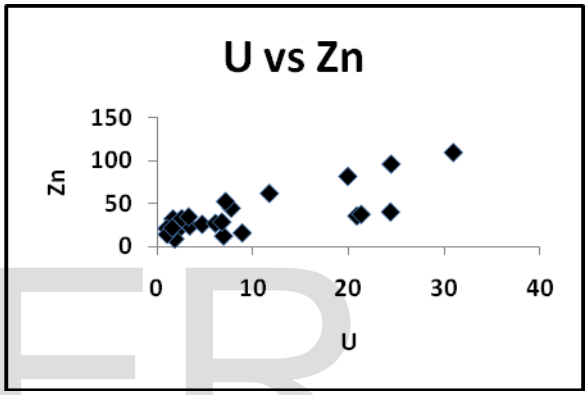

Fig 25. Concentration of U vs Zn

The above maps illustrates EC (fig no. 16) & uarnium (fig no. 17) shows that as pH increases, the concentration of uranium increases and EC is decreased near the unconformity zone of uranium. Based on the properties of oxidation and reduction of oxides, the uranium shows the influence on the pH.

Fig 17 shows that concentration between EC and uranium, EC is inversion relation to uranium this indicates as EC increases the concentration of uranium decrease. EC shows reciprocal relation with pH in Akkavaram soils.

Over half of the world, current production is from so called "unconformity type" deposits, these deposits were typically formed between 1800 to 1200 Ma, and generally uranium shows higher concentration at neutral level of pH in primary environment (Daryl Hockley et al.). Chemical speciation of uranium (VI) in soils is highly dependent on soil composition on the pH in the soil solution (Guillaume et al., 2001) the uranium was transported under unexpectedly low pH conditions and at the higher concentrations recorded in crustal fluids (A. Richard et al. 2010). There is needed significant positive positive correlation between pH and the export of uranium but not for thorium. Higher pH tends to leads to higher export of uranium and higher average concentration of uranium in stream water, there is negative correlationship between pH and wetland coverage of uranium (F. Lidman et al, 2012).

III. Conclusion:

Akkavaram is identified as unconformity related uranium mineralization in Srisailam sub basin. As

per the United States Department of Agriculture and Natural Resources Conservation Services norms, the study of pedogeochemistry in Akkavaram area shows the pH & EC is not exceeded the permissible limit of the soil. If the pH is below neutral, uranium & associated elements are stable in oxide form; EC shows reciprocal relation with pH in Akkavaram soil. It has been observed that the pH more than 6.0 in proximity zone and pH ranging from less than 6.0 away from the unconformity zone. It can be concluded that along the unconformity zone, the uranium mineralization is observed and have the pH is above 6.0 (UD/S-1) and low value of Electrical Conductivity. Away from the unconformity zone the pH indicates low that the uranium is mobile and EC is decreases. Based on the above information concluded that the unconformity related uranium mineralization slightly influenced on soil pH and Electrical Conductivity.

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