Geochemical Aspects of Serpentinite Bodies at Ginigalpelessa Off Ambilipitiya, Sri Lanka

HPKSA Kumara, PS De Silva, MNP Dushshantha , WDS Madhusanka and *S Weerawarnakula, HMRPremasiri and AMKWAbeysinghe.

**Corresponding author - sarath89@hotmail.com*

Abstract: Ginigalpelessa Serpentine bodies are located along major tectonic boundary between Highland and the Vijayan Complexes – in the South Eastern part of Sri Lanka. Ultramafic rocks and their soils are rich with specific metals such asFe, Mg, Mn, Ni, Co and Cr. Release of certain metallic elements from weathered rock to soil and their in situ concentration have been identified. "MorindaTInctoria" plants which is wide spread in the area is restricted to area underlain by Serpentinite bodies.

Ni concentration in the rocks varies between 2250-3340ppm while over 100% – 175% increase in concentration is found in soil. The plant "MorindaTInctoria" shows high concentration of Ni compared to the same plants collected from elsewhere in the country. The restriction of the plant to the particular area and its growth pattern in the area indicate that the plant could be used as an indicator plant for identifying higher concentration of Nisoil . Increased element concentration from the bed rock to soil has been identified for Fe (260%) Mn (270%), Co (280%) and Cr (over 6700%) Decreased element concentration has been identified for Mg (580%). Very high Cr values found in soils (over 14000ppm of Cr in soils) leads to investigate the effect of Cr for human health in the area.

Keywords: Ginigalpelessa, Ultramafic rock

1. Introduction.

Geologically, Sri Lanka is underlain by 80% of Precambrian age rocks and 20% of Miocene Limestone rocks which are restricted to North-Western area of the Sri Lanka. Considering the rock types, origin and their metamorphic conditions, metamorphic terrain is divided in to four main groups and namely Highland Complex (HC), Vijayan Complex (VC), Wanni Complex (WC) and one subunit Kadugannawa Complex (KC). Identified Serpentinite outcrops in Sri Lanka lie along the boundary of the HC and VC. Those well identified deposits are,Yodhagannawa, Ginigalpelessa, Indikolapelessa and Ussangoda.

Serpentine is a major rock forming mineral and is found as a constituent in many metamorphic and igneous rocks. Serpentine's structure is composed of layers of silicate tetrahedrons linked into sheets.

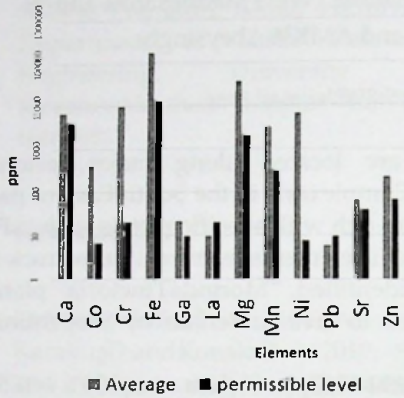

Figure 10- Comparison between Average Test Results and Mean Levels in Normal Soil

Normally these rocks are rich in metals like Ni, Co, Cr, Fe and Mg. Also the soils derived from serpentine outcrops provide poornutrients for plants and heavy concentration of some metals. The areas underlain by Serpentine rocks are generally barren lands with little or no vegetation. Therefore boundaries of such bodies can be identified easily with the difference between the vegetation.

In Embilipitiya, South Eastern part of Sri Lanka, there are two known Serpentine bodies in Ginigalpelessa and Indikolapelessa area. In the work carried out compositional variations over the Ginigalpelessa serpentine body were tested. Concentration of metallic elements in soil overburden was compared with composition of the bed rock. Furthermore absorption of metallic elements by typical plants restricted to the area was checked.

2. Material and Methods.

Followings are the method of investigation of the serpentine body.

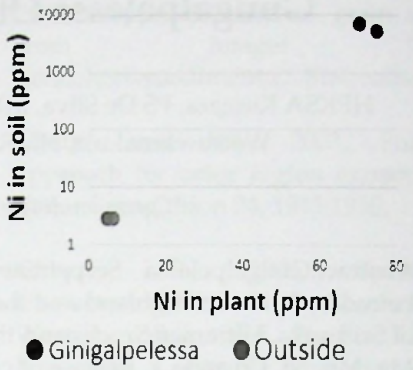

Figure 2.Relationship of Ni Concentration in Plant and Soil.

2.1 Desk Study

Desk study was carried out with aid of literature reviews of the related serpentine, study of the interested area by referring the maps of the area.

2.2 Field Study/Work

Identifying the boundary of the serpentine body was done by field observations and satellite (google) pictures using vegetation cover.Rock, Soil and Plant samples were collected from each identified location to represent the serpentinite body.

2.3 Sample Preparation

After drying, quartering, the samples were grinded using Tema Mill.

2.4 Sample Analysis

Prepared samples were analyzed partially for certain elements using AAS in the department and Major part of the total analysis were carried out in ALS laboratories, in Peoples

Republic of China, for major and trace elements using ICP and AAs.

3. Results.

The table below shows the average concentrations of the elements for weathered rock, soil and plant samples

Table 3.Average Concentrations in Sampled Weathered Rocks, Soil and Plants.

Element	In W. Rock	In Soil	In Plant
As(ppm)	0.68	5	0.12
Au(ppm)	0.20	0.20	0
Ba(ppm)	15.00	200	12.9
Bi (ppm)	0.02	9	0.01
Cd(ppm)	0.04	0.63	0.05
Co(ppm)	108	409	1.25
Cr(ppm)	206	14000	4
Cu(ppm)	3	12	35
Ga(ppm)	0.20	22.5	0.12
La(ppm)	0.3	10	0.44
Li (ppm)	0.63	ND	0.25
Mn(ppm)	838	3102	124.5
Mo(ppm)	0.05	1.75	0.29
Ni(ppm)	2961	6460	72
P (ppm)	30	385	0.26
Pb(ppm)	0.53	6	1.33
Rb(ppm)	0.28	ND	28
Sc(ppm)	7	21	0.09
Sr (ppm)	5	66	23
V(ppm)	10	143	1
Zn(ppm)	12.	236	48
Al %	0.11	3.14	0.04
K %	0.01	0.25	2.49
Fe %	5	18	0.08
Mg %	20.95	3.62	0.82
Ca %	0.2	0.69	1.76
Na %	0.01	0.29	0.05

4. Discussion.

As shown in the results, Ni, Cr, Co, Fe, Mn, Zn and Mg have recorded in high concentrations while Ca, Sr and Ga have recorded in moderately high concentrations than the mean values in normal soil environment. Deviations of results from the mean values of normal soils is clearly illustrated in figure 1.

According to the test results, there is a significant interrelationship between Ni, Cr, Co, Fe, and Mg as in serpentiniterock environments.

The plant that we used to analyze is "*Morinda.TInctoria*". High concentration of Ni has been observed in plant samples. According to the figure 2 the same plant samples collected from outside (Warakapola and Alawwa) show less Ni concentration than the Ginigalpelessa area. This is a good indicator for the high Ni presence in the researched area.

There is no significant difference in the Au concentrations between outside samples and researched area. Co, Ni, Mn, Pb are slightly mobile in oxidizing environments while Au is considered as immobile. This can be a reason to not having a significant different between plant samples between outside and the researched area. However marginal concentration of Au has been concentration in the soil.

High concentration of Ni, Co, Cr, Zn, Mn and Fe in soil could endanger the

health of human settlers of the area around Ginigalpelessa. Furthermore chromium concentration is very much higher than the permissible level. Such high concentrations of chromium may damage human health badly. Health problems that are caused by high chromiumconcentration are: Skin rashes, ulcers, weakened immune systems, kidney and liver damage, alteration of genetic material and sudden death can be take place. Nickel will cause higher chances of development of prostate cancer, Sickness and dizziness after exposure to nickel gas, birth defects, and allergic reactions such as skin rashes and heart disorders. High concentration of cobalt, also cause gastro intestinal disturbances, problems in thyroid gland and problems in vision.Thezinc and Iron concentrations are also higher, than the permissible levels. Suchconcentrationscouldcause toxic effect to the body, malfunctioning of human body.

5. Conclusion.

Serpentine body located in Ginigalpelessa - Embilipitiya was sampled in order to find out the major and trace elements present in the rocks and soils. Ginigalpelessa Serpentine body represents properties of ultramafic rocks and rich with nickel (Ni), cobalt (Co), chromium (Cr), iron (Fe), magnesium (Mg) and Manganese (Mn). Serpentine body is nearly spreaded over an area of 1km^2 and total area shows similar geochemical behaviours. "MorindaTInctoria" plant is identified as a good indicator for Ni concentration. The area is identified as a poor nutrient zone for vegetation due to absence/poor concentrations of of K, Ca and Na. For human health, it is identified that soils derived from serpentine body contains high concentration ofNi, Cr, Co, Fe, Mn and Zn which are hazardous to human health.

Acknowledgements

The authors would like to express their sincere gratitude to academic and non-academic staff of the Department of the Earth Resources Engineering of University of Moratuwa for the support given during field and laboratory work of the project.

References

Vithanage,M., Rajapaksha, A.U, Oze, C and Rajakaruna, N., 2014. *Metal release from serpentine soils in Sri Lanka.*a t:http://www.researchgate.net/profile/Anushka_Rajapaksha/publication/259918688_Metal_release_from_serpentine_soils_in_Sri_Lanka visited, 12. 11. 2014.

Rajakaruna, N., 2004. *Serpentine : A Model Habitat for Botanical Research in SriLanka.*at:

Hewawasam,T., Fernando,GWAR Priyashantha,D., 2014. *Geo-vegetation Mapping and Soil Geochemical Characteristics of the Indikolapelessa Serpentinite Outcrop, Southern Sri Lanka.*

At:http://www.researchgate.net/profile/Tilak_Hewawasam/publication/259457610_Geovegetation_Mapping_and_Soil_Geochemical_Characteristics_of_the_Indikolapelessa_Serpentinite_Outcrop_Southern_Sri_Lanka. visited,05. 01. 2015.