GOLD OCCURENCES IN SOME CLAY MINERAL – RICH SOIL PROFILES OF CENTRAL SRI LANKA

G.Y.M.N.T. Ilangakoon and K. Dahanayake

Department of Geology, Faculty of Science, University of Peradeniya

Introduction

Clay minerals are hydrous layer silicates formed by tetrahedral and octahedral silicate structures that constitute a large part of the family of phyllosilicates. Depending on the arrangement and ratio of octahedral and tetrahedral silicate structures, two major classes of clay minerals have been identified as Kaoline group (T.O.) and Smectite group (T.O.T.). Clay is a major part of a weathering/soil profile. The type and amount of clay in a soil profile depend on several major factors. They are (i) rock structure (ii) rock mineralogy and geochemistry (iii) topographic and hydro-geological conditions and (iv) rainfall intensity. Depending on the above parameters, different types of soil profiles with varying thickness develop mostly on ridges. The soil profiles are composed of one or more horizons formed on given bedrock with different mineralogies. The horizons show sequence/s of thin/thick layers of materials with different physical and chemical properties. These layers can be composed of clayey, sandy or gravelly materials mixed with different minerals and rock fragments. In a typical soil profile, the following sub-divisions are recognized residual soil, weathered rock and relatively unweathered fresh rock. Clay minerals are formed predominantly on the residual soil where three major zones can be identified as Horizon A- humic materials with sandy texture, Horizon B –mostly dark coloured and rich in clay sized materials with accessory sands and Horizon C- host rock with materials which are more soil-like than rock-like that may contain certain native elements (Figure 1). The host rocks in the study area are Precambrian gneisses, charnockites, marble or quartzite. It was observed that the thickness and geochemistry of the soil profiles changed with the mineralogy of host rock, solubility and leaching rate of major cations such as Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{2+}/Fe^{3+} and Mn^{2+}. The purpose of this paper is to study the mineralogy including clays and structures of some selected soil profiles developed on different rock types of the Sri Lankan Precambrian.

Materials and Methods

A reconnaissance survey of soil profiles developed on different rocks of the Precambrian of Sri Lanka was undertaken in the field on the Gampola-Nuwara Eliya Road and Kandy- Badulla Road. Based on the field observations, seven soil profiles were selected on different rock types such as gneisses, charnockite, marble and quartzite. In the gneisses of different composition, soil profiles were well developed with all three horizons easily visible to the naked eye. In charnockites and quartzites, the different horizons of the soil profile were faintly developed whereas in marble, it was often lacking. The samples collected from different horizons of soil profiles were studied for their clay mineralogy and geochemistry using Differential Thermal Analysis (DTA), X-Ray Diffractometry, X-Ray Fluorescence (XRF) and Atomic Absorption Spectroscopy (AAS).

Data collection and pre-processing

The collected samples were sieved and one part of the portion remaining on the pan was used for acid digestion (3: 1 = HCl: HNO_3) and the other portion was used for XRD, XRF and DTA analyses. The geochemical variations of soils were determined using the digested (partial acid digestion with HCl and HNO_3) samples with the AAS.

Results

The soil profiles on gneisses were well developed with thick C horizons and kaolinite was found to dominate the A-horizon (Figure 2). The clay mineralogy of B-horizon was formed mainly by Fe-Mg substituted clay minerals such as montmorillonite, antigorite, chrysotile etc. (Figure 3). C-horizons in gneisses contained Fe-Mg substituted minerals such as antigorite, illite and montmorillonite (Figure 4). In soil profiles developed on pink granites, kaolinite dominated in all three horizons. In quartzites, charnockite and marble, the clay mineralogy was more heterogeneous with kaolinite and halloysite being more prominent. Clay horizons were dominant in gneissic host rock. In charnockites, quartzites and marble the clay horizons are thin or absent depending on topographical conditions.

In almost all well developed soil horizons, principally in gneisses, the major oxide observed in the soil was Fe_2O_3 and in an individual soil profile, the Fe_2O_3 percentage decreased with depth (Figure 5). In a few locations, the soils indicated relatively high percentages of Gold (Au) and Platinum (Pt). However, the modes of occurrence of these elements are not very clear and more work needs to be done.

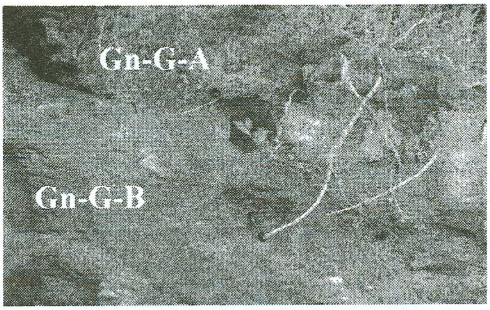

Figure 1. Soil samples collected on a profile developed on gneissic host rock (A, B and C refer to soil horizons formed in biotite gneiss)

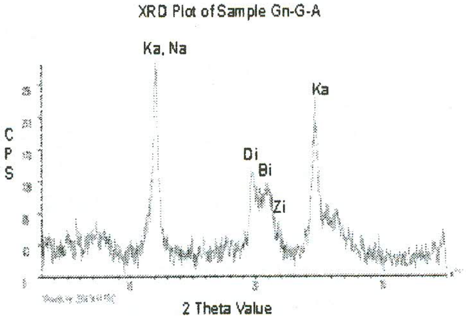

Figure 2. XRD plot of sample Gn-G-A of Figure 1

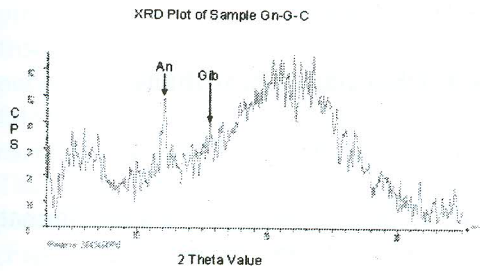

Figure 3. XRD plot of sample Gn-G-B of Figure 1

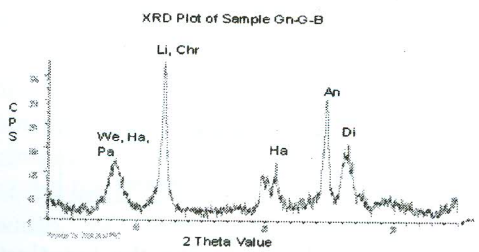

Figure 4. XRD plot of sample Gn-G-C of Figure 1

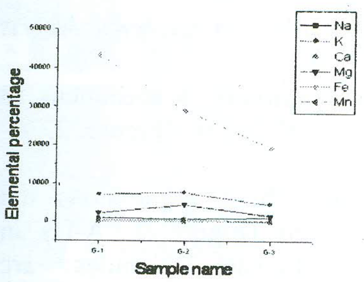

Figure 5. Elemental variation of soils at samples G1, G2 and G3 from Gn-G-A, Gn-G-B and Gn-G-C

Discussion and Conclusions

In the gneissic rocks, the soil profiles are very thick and the clay mineralogy varies from topmost Horizon A to the Bottom horizon (Horizon C) which is in contact with the host rock. The Horizon A is dominated by the kaoline group clays such as kaolinite whereas the horizon B & C are dominated by the smectite group clay minerals such as montmorillonite, illite and mixed clays because of the decrease of leaching probability of major cations from top to bottom along a vertical profile. This variation is characterized by the results of the oxide variation of the profile which is indicated by the concentrations of major oxides in the soil outside the clay structure.

Our preliminary observations indicate the potential occurrence of economically minable Gold (Au) and Platinum (Pt) in some of the soil profiles studied. Further work is needed to confirm such findings.

References

Cooray, P.G., (1992). The Precambrian of Sri Lanka: a historical review, Precambrian Research, 66: 3-18.

Herath, M.M.J.W., (1995). Industrial clays of Sri Lanka, Handbook on Geology and Mineral Resources of Sri Lanka, K. Dahanayake (ed), GEOSAS-11, Colombo, Sri Lanka.19-24.

Ilangakoon, G.Y.M.N.T, (2009). Clay mineralogy and geochemistry of soil profiles developed on metasedimentary rocks of Kandy and Gampola areas. BSc thesis submitted to Dept. of Geology, University of Peradeniya. 69.