Preliminary Study on Mineral Identification in Sediment from Sungai Nal, Ulu Sat Forest, Kelantan, Malaysia

To cite this article: Teo Pao Ter *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **596** 012049

IOP Conf. Series: Earth and Environmental Science **596** (2020) 012049 doi:10.1088/1755-1315/596/1/012049

Preliminary Study on Mineral Identification in Sediment from Sungai Nal, Ulu Sat Forest, Kelantan, Malaysia

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Abstract. Ulu Sat Forest, Kelantan is rich with various biodiversity and been protected and reserved from any illegal logging activity. Previous studies mainly focus to explore biodiversity of the forest, without any in-depth investigation to explore mineral distribution in soil. This paper is baseline study which investigated mineral distribution in sediments from different sites of *Sungai Nal* (Nal River), as well as different core depth, which were situated at Ulu Sat Forest, Kelantan, Malaysia. Total of five surface sediment and one core were analyzed with x-ray diffraction (XRD) phase analysis, it was found that despite of sampling location and sampling core depth, the soil merely consisted of quartz (SiO_2) mineral, without any traces mineral been detected. However, concentration of the quartz mineral did vary with the sampling locations as well as core depth of the sampling. Thus, mineral distribution in the soil was consistent as only quartz was detected by XRD analysis.

1. Introduction

X-ray powder diffraction (XRD) is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions [1]. It is most widely used for the identification of unknown crystalline materials (e.g. minerals and inorganic compounds) and beneficial to geology, mining and mineral processing industry [2]. This includes baseline study to investigation variation of mineral distribution in a specific sampling area. Several researchers have reported the application of XRD to investigate variation of distributed minerals in clay deposits and soil sampling areas [3]. They found that several types of minerals present such as kaolinite, hematite, smectite, illite and quartz. The samples were collected from large sampling areas across different countries in Asian, Europe and North American, yielding to the variation of distributed minerals.

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Ulu Sat Forest, Kelantan is one of reserved forest under the Forestry Department of Peninsular Malaysia. It is rich of various biodiversity and been protected and reserved from any illegal logging activity. Most of previous studies mainly focus to explore biodiversity of the forest including plant and animal species as well as environmental ecology of the livings, without any in-depth investigation to explore mineral distribution in geological soil of the Ulu Sat Forest [4]. Therefore, considering the gap of knowledge, this baseline study sought to investigate the mineral distribution in sediments from Sungai Nal, Ulu Sat Forest.

2. Materials and Methods

Total of five surface sediments and one sediment core were collected at the Ulu Sat Forest, namely *Sungai Nal* (Nal's River) (Figure 1). The sediment samples is collected at five different location from upstream to downstream, as shown in Table 1. Surface sediment samples at sampling site A-D were collected using grab sampler. While, core sediment samples were collected at sampling site E using gravity corer. The procedures of sample collection followed the procedure published by Yusoff and Mohamed (2019) [5].

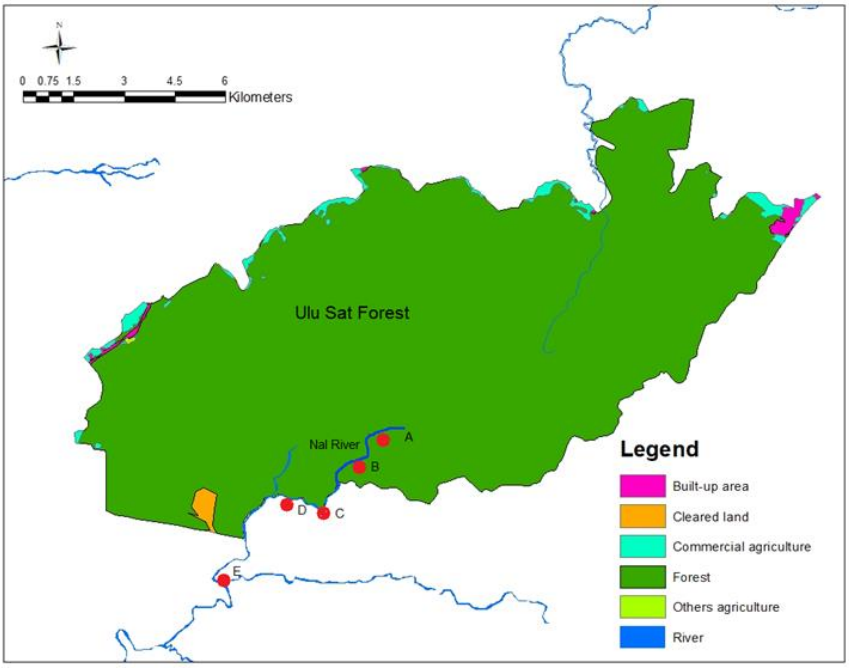

Figure. 1. Sampling location at Nal River, Ulu Sat Forest, Machang Kelantan

Table 1. Location (latitude and longitude) at *Sungai Nal*

Samples	Latitude	Longitude	pH of River during Sampling	Types of samples
A	5.68499	102.3286	6.8	Surface (sand)
B	5.66801	102.3225	6.6	Surface (sand)
C	5.67377	102.3122	6.6	Surface (sand)
D	5.66427	102.2977	6.7	Surface (sand)
E	5.64193	102.2753	6.8	Core (mix of sandy mud)

Prior to XRD analysis, the samples were dried in an oven at 100 ºC for 24 hours. Upon drying, the soil samples were grinded in a pulveriser to obtain powder with particle size of less than 75 µm prior to

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the XRD analysis. Subsequently, XRD analysis was performed using Bruker D2 Phaser diffractometer with voltage and current source of 40 kV and 40 mA, respectively. The diffractometer was equipped with Cu-Kα radiation (λ = 0.154 nm) and scanning was conducted at step size of 0.0340, with scanning range (2θ degree) of 10º - 90º. The output of the XRD analysis was diffraction pattern graph with peak's intensity versus 2θ degree. Subsequently, mineral phase identification analysis is performed using DIFFRAC EVA 3.2 software by comparing experimental XRD pattern obtained from soil sample with theoretical XRD pattern from Crystallography Open Database (COD).

3. Results and Discussion

XRD profile peaks of soil sampled at four different locations of *Sungai Nal* is depicted in Figure. 2. By observing and comparing the XRD peaks for sample A, B, C and D, it is clearly shown that the peaks had similar pattern. This indicated that similar mineral phase would present in the soils although the soils originated from different site locations. Upon phase identification, it was revealed that the soils merely consist of quartz (SiO_2) mineral phase (COD: 9009666) without any traces mineral been captured by the XRD. Although the profile peaks had similar pattern, intensity of the peaks varied with different soil samples. The intensity of peaks was decreasing from soil A to D, indicating that amount of quartz was decreasing from soil A to D as well.

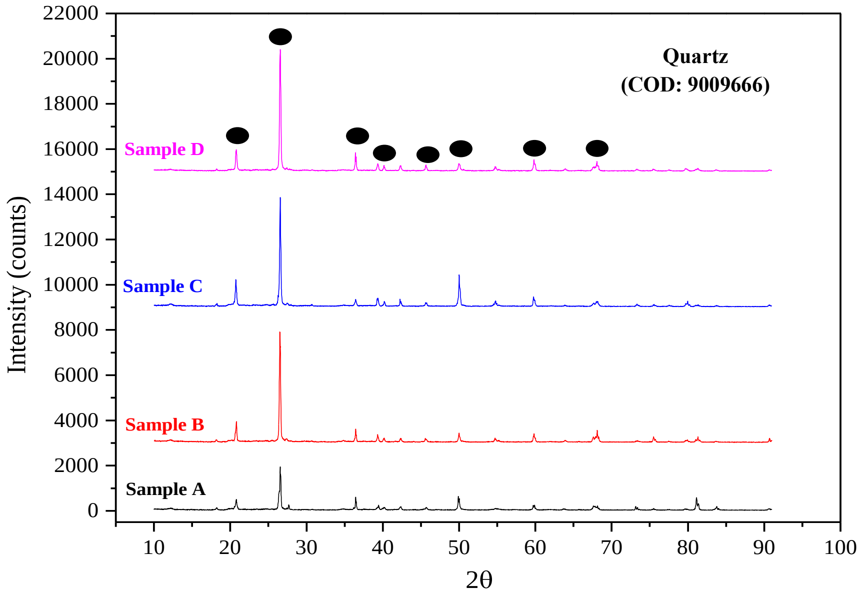

Figure 2. XRD profile peak of soils sampled at different locations of *Sungai Nal*

This phenomenon could be explained in terms of active leaching of the soil during weathering process [6]. As geographical characteristic of the river surface could vary with different location, this will lead to variation of weathering process experienced by the soil [7, 8]. It is anticipated that active leaching process would progressively leach away Si from the quartz and degrading the amount of quartz deposited in the soil. Upon stream of river water, the leached Si will then re-deposited again as quartz in another location. Therefore, this could lead to variation of concentration of quartz deposited at the distinct surfaces (Surface A, B, C and D) of the *Sungai Nal*.

Meanwhile, XRD profile peaks of core sediments is shown in Figure. 3. The XRD profile peak of Figure. 3 clearly indicates that the layer of sediments had similar pattern of peaks despite of core depth. This implied that similar mineral phase would present in the soil sample. Phase identification has revealed that the soils merely consist of quartz (SiO2) mineral phase (COD: 9009666). As discussed previously, the soil samples were taken over a small range of core depth down to about 27 cm. The XRD

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analysis has revealed that there was no apparent consistent variation in mineral distribution related to depth within the cores, with merely quartz existed in the soils. Similarly, none of other mineral traces been detected by the XRD. Although quartz was the main mineral phase present in the core sample, intensity of the quartz peaks was inconsistent and varied with the core depth. This could be explained in terms of rate of sedimentation during deposition of the quartz in the soil. It was reported that rate of sedimentation would vary with core depth of the geological soil [9]. Subsequently, this would affect chemical reaction and diffusion to form the quartz in the soil, yielding to different concentration of quartz been detected at different core depth [10].

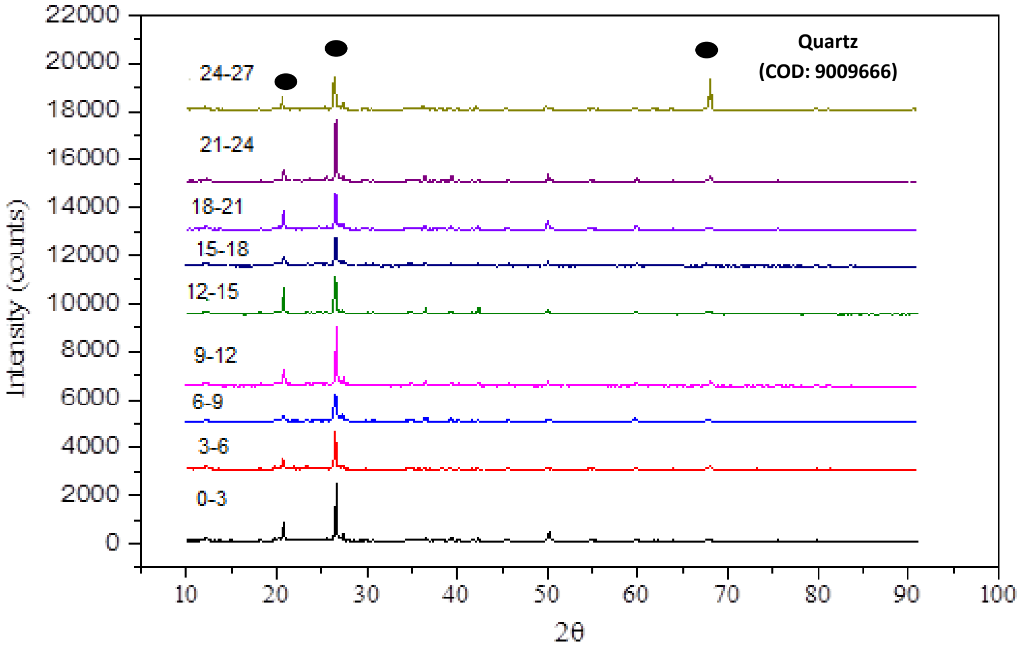

Figure 3. XRD profile peaks for sediment core (0-3 cm to 24-27 cm) sampled via gravity corer

4. Conclusion

At the end of this study, it can be concluded that the sediment samples at *Sungai Nal* of Ulu Sat Forest merely consisted of quartz mineral phase. None of other traces mineral phases was detected. Concentration of the quartz mineral varied with sampling locations as well as core depth of the sampling. Thus, mineral distribution in the sediments from *Sungai Nal* was consistent as merely quartz was detected by XRD analysis. In future, other much sensitive (up to ppm level) analytical instruments such as atomic adsorption spectroscopy (AAS) and induced coupled plasma-mass spectrometer (ICP-MS) could be employed to thoroughly detect any of traces minerals in the soil samples.

Acknowledgements

The authors would like to thank Kelantan Forestry Department and Faculty of Bioengineering and Technology for financial support in completing this research project. Thanks also to Universiti Kebangsaan Malaysia- Yayasan Sime Darby (UKM-YSD) and Universiti Malaysia Kelantan (UMK) for providing research grants code no: R/YSD/A1304/01684A/002/2019/00608 and grant code no: R/SGJP/A1300/01684A/001/2019/00581, respectively.

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