International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2021 Vol. 11, pp. 120-124/Khusainov and Stelmakh
Research Article

PALEOMAGNETIC INVESTIGATION OF THE LOESS-SOIL SEDIMENTS OF THE KADYRYA SECTION OF THE CHIRCHIK RIVER BASIN, UZBEKISTAN

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ABSTRACT

This article reflects paleomagnetic inclinations of the loess-soil sediments of the Chirchik river basin were determined from samples of the Kadyrya section. The main goal of the work was to establish the intervals of direct and reverse magnetization of samples and to identify the paleomagnetism of the loess-soil sediments of the section under consideration. A complex of paleomagnetism methods was determined as the parameters of the natural remnant magnetization and magnetic susceptibility of the selected of the loess-soil sediments and the direct and reverse magnetization intervals were established including short-term geomagnetic deviations. Results show that samples of loess-soil sediments in the lower part of the Kadyrya section were deposited during the Matuyama polarity epoch.

Keywords: *Kadyrya section, Chirchik river basin, Matuyama-Brunhes boundary, palaeomagnetic method, quaternary period, loess-soil sequence*

INTRODUCTION

Soil formation of Uzbekistan occurs under the influence of a wide variety of natural factors, which leads to the formation of various types of soils. In the process of soil formation, the rock (parent rock) differentiates into a number of interconnected horizontal layers. Soil formation manifests itself following the weathering process. In the process of weathering, geological deposits are transformed and the rock becomes more susceptible, more ready for the influence of soil processes on it. Before the beginning of the soil-forming process, in the process of weathering, crushing and loosening of the parent rock begins, then the rock acquires the properties of water capacity and air capacity. Secondary minerals are formed, differentiation takes place according to granulometric, mineralogical and chemical compositions. As a result, properties appear in the stratum of the parent rock that favors the development of specific soil characteristics.

Quaternary deposits of the Chirchik river of Uzbekistan basin are exclusively represented by loess rocks of various genesis. Their thickness reaches 70-90 m. They are the parent rock for both modern and ancient soils. There are buried (fossil) soil layers in the thickness of loess-like deposits. They formed during the entire Quaternary period. Holocene, Pleistocene and Eopleistocene soils are sometimes traced in complete sections of loess strata in the Chirchik river basin (Abdunazarov and others, 2020). The soils of the loess sections of study area, since they were formed at different times, under different climatic conditions and different geomorphological levels, retained the imprints of events of the geological past. The magnetometric method makes it possible to read soil-geological events of the past through magnetic diagnostic features.

This article presents the results of studies of the magnetic deposits of the Kadyrya section in order to analyze the patterns of changes in the paleomagnetic characteristics of the Quaternary loess-soil strata of Uzbekistan and determine the key stratigraphic paleomagnetic markers, in particular, the Matuyama-Brunet boundary.

MATERIALS AND METHODS

The materials for this article were collected during the thematic works on the topic "Study of evolution and assessment of the degree of change in modern and fossil soils of the Quaternary period of Uzbekistan by the magnetometric method in order to develop practical recommendations in geological and soil science" in the period from 2016-2020 in the National University of Uzbekistan.

The maximum information on the paleomagnetic characteristics of the loess-soil rocks of the Kadyrya section was obtained on the basis of a comprehensive analysis of paleomagnetic field and laboratory studies. The paleomagnetic technique is quite fully developed and described in many classical publications (Khramov, 1967; Khramov, 1982). The magnetic properties of loess rocks, including soils, like any substance, are manifested in their ability to magnetize in a magnetic field. One of the most important indicators of the magnetic properties of rocks and soils are magnetic susceptibility (χ), natural remanent magnetization (In), viscous magnetization (Irv), and Qn factor (a measure of the preservation of primary magnetization) (Khramov, 1967; Khramov, 1982).

When carrying out field paleomagnetic studies, at the first stage, two or three oriented samples of a cubic shape with an edge of 5 cm were taken from the working wall after stripping the outcrop of the section. Sampling started below the level of the first soil horizon. Loess-soil rocks of the section were sampled continuously at intervals of 0.25 m. The second stage of work consisted in carrying out paleomagnetic laboratory studies in order to identify the primary and secondary magnetization of rocks. All selected samples went through a full measurement cycle according to the method of Khramov (Khramov, 1967; Khramov, 1982). In the course of these studies, the values of the components of the natural remanent magnetization and magnetic susceptibility were determined. In addition, all samples of the collection rocks were subjected to temporary cleaning, the method of compensation of viscous magnetization.

RESULTS AND DISCUSSION

Loess-soil deposits of the Kadyrya section are located on the watershed between the Chirchik and Keles rivers near the Kibray settlement and characterize the structure of the Pleistocene-Eopleistocene deposits on the plain (fig. 1). The boundary between the loess-soil stratum and underlying siltstones in the section is clearly expressed by the lithological, genetic and colour characteristics of the sediments.

Figure 1: General view of loess-soil sediments of the Kadirya section of the Chirchik river basin, Uzbekistan

The Kadyrya section according to the lithological structure is clearly divided into two parts: the upper one consisting of loess-soil formations with a depth of 25.8 m and the lower one consisting of dense marl loam of 4.5 m or more depth. Sedimentation depth is not full.

Let us consider the lithological structure of the section which is represented by the following sediments from top to bottom (depth, m):

1) Modern soil, loam, light greyish brown, lumpy, dry, fractured, clear transition (0.25);
2) Buried soil (BS -1), loam, light brown, lumpy, with dense clay nodules 1.5-3.0 cm long, 0.5-1.0 cm in diameter, their number increases towards the middle of the layer, the transition is gradual (2.66);
3) Loam, tan, finely lumpy, porous, uniform, clear transition (2.00);
4) Buried soil (BS -2), loam, greyish-brown, macroporous, calcareous, with dense clay nodules up to 3.0 cm long, up to 2.0 cm in diameter, increases towards the middle of the layer, gradual transition (1.40);
5) Loam, light greyish brown, finely porous, uniform, finely lumpy, calcareous, dense, clear transition (4.30);
6) Buried soil (BS -3), loam, greyish brown, macroporous, with dense clay nodules up to 3.0 cm long, up to 1.0 cm in diameter, they increase towards the middle of the layer, lumpy, gradual transition (4.60);
7) Loam, greyish brown, finely porous, uniform, finely lumpy, calcareous, full, clear transition (5.30);
8) Buried soil (BS-4), loam, brown, macroporous, lumpy, calcareous, with dense clay nodules up to 3.0 cm long, up to 1.0 cm in diameter, they increase towards the middle of the layer, gradual transition (3.60);
9) Loam, greyish brown, finely porous, calcareous, uniform, dense, clear transition (1.80);
10) Siltstone, brown with a reddish tint, finely porous, calcareous, homogeneous (3.80).

The total uncovered depth of the section is 30 m.

The results of paleomagnetic studies of the rocks of the Kadyrya section showed that the natural residual magnetization In down the section varies non-uniformly $(0.5\text{-}24.1)*10^{-6}$GHS, and the magnetic susceptibility is generally maintained along the profile and varies in the range $(4.0\text{-}10.5)*10^{-6}$GHS, with $\chi_{av}=5.2*10^{-6}$GHS (fig. 2).

The high In values in the section are accounted for directly magnetized loess-soil sediments, and low for dense directly and backward magnetized loams and siltstones. The most underestimated values of In rocks are observed when the polarity of the geomagnetic field is changed. In the section they are at 15.2 m, 22.3 m and 25.2 m.

With such a wide range of variation of the In value, the magnetic susceptibility is generally maintained over the section and does not correlate with a change in In. This is explained by the fact that the material composition of the rocks is homogeneous and sustained along the section.

Soil sediments, despite the post-sedimentation transformations, are not subject to significant changes. These changes only slightly affected the magnetic viscosity of the rocks. Variations In are related to the state of the geomagnetic field. Here, as in the preceding section, two epochs of the geomagnetic field are recorded, the direct one corresponding to the Brunhes epoch and the reverse one corresponding to the epoch. Loess sediments in this section begin at the mark of 1.6 million years.

Paleomagnetic studies have established that the loess part of the section is directly magnetized to a point of 15.2 m (D_{av}=50; J_{av}=580), from 15.2 to 25.8 m it is magnetized by a straight line ($D_{av}=5^0$; $J_{av}=60^0$) and reverse polarity ($D_{av}=180^0$;$J_{av}=-58^0$). Dense marl loams of the section from 25.8 to 30.0 m are exclusively *magnetized* reversely ($D_{av}=182^0$; $J_{av}=59^0$).

When summarizing the obtained material with information from other sections of loess-soil sediments, it was found that the studied section characterizes the accumulation of Quaternary sediments in the orogenic and platform regions of Uzbekistan [Li Qiang and others, 2020]. In this section, unlike the sections of the platform region of Uzbekistan, the continuation of the events of the geomagnetic field of the Eopleistocene was recorded. If in the orogenic region the events of the geomagnetic field are recorded in diluvia sediments, then in the Kadyrya section they are established in proluvial loess-soil sediments. Further recording of the geomagnetic field is noted in dense, highly calcareous alluvial marls.

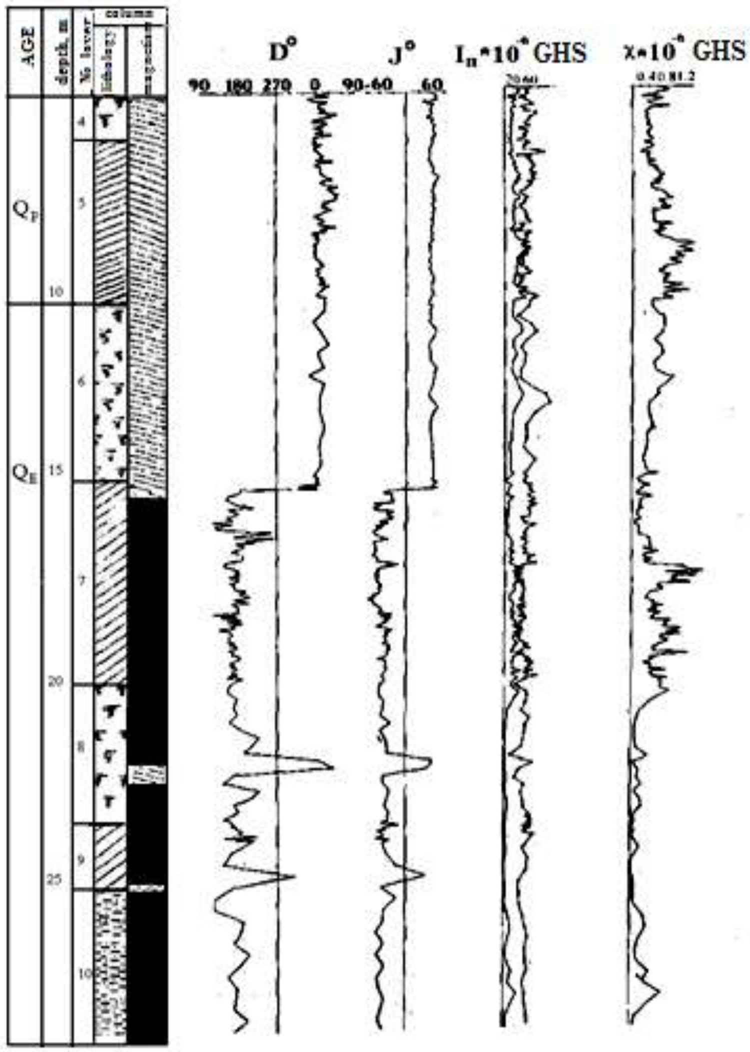

Figure 2: Paleomagnetic characteristic of loess-soil sediments of the Kadyrya section

In general, it can be noted that the lower part of the Kadyrya section is correlated with Matuyama's chron of reverse polarity, and the upper part is correlated with Brunhes's chron of direct polarity (Toychiev and others, 2019).

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