Preliminary magnetostratigraphic data of a Tatarian (Upper Permian) section on the Volga river (Russia)

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ABSTRACT

A magnetostratigraphic profile of the uppermost Tatarian (Upper Permian) of a section of continental sediments from Eastern Platform is presented. Around 300 samples across an Upper Permian sequence of red beds Monastirskoje on the Volga River Valley (South-West of Tatarian, Russia) have been collected. The characteristic primary component defined nearly for all the examined samples has a normal as well as reversed polarity, therefore a clear polarity zonation is defined.
The fold test, carried out on samples collected in the nearby section of Titjuschin where the sediments are exposed in a fold structure, indicates that the characteristic magnetization pre-dates the folding.

RESUMEN

Se presenta el perfil magnetoestratigráfico del Tatariense (Pérmico Superior) de una sección de sedimentos continentales de la plataforma del Este. Se recogieron alrededor de 300 muestras a lo largo de una serie continua de red beds en Monastirskoje, en el valle del Volga, (Suroeste de Tataria, Rusia). La componente característica primaria en todas las muestras examinadas presenta tanto polaridad normal como invertida, por lo que se ha definido una clara secuencia de polaridad. Se ha llevado a cabo un test del pliegue en rocas próxima a la sección de Titjuschin donde los sedimentos han experimentado fuertes plegamientos, que ha indicado que la magnetización característica es previa al plegamiento.

Key words: *Palaeomagnetism, magnetostratigraphy, Tatarian, Russian Platform, Kiaman.*

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Introduction

Geological situation: In the Early Cambrian, sedimentary basins, related to active graben system defined during the Rifean time, were formed along the margin of the Russian Platform Nalivkin (1976). The subsidence rate of the basins was discontinous allowing for several major marine transgressions during the Paleozoic. Marine, lagoond and continental enviroment characterizes the deposition during the Upper Permion. The sediments characteristic are: sandstones, clays, marls, dolomites, limestones, with typical paralic flora and fauna Chepikov & Blom (1967).

Along the Volga river on the Eastern of the Russian platform, the Upper Permian contains the stratotype areas of the Ufimian, Kazanian and Tatarian stages. The Ufimian is characterized by marine, lagoonal and continental sediments, the Kazanian is represented practically only by marine deposits, whereas the Tatarian sedimentation represents the return to mainly lacustrine conditions. Sediment thickness varies considerably, but reaches several hundred meters Ignatjev (1962), Forsh (1963).

Previous study: Paleomagnetic studies in Russia were carried out initially to compile a standard regional palaeomagnetic scale for the Palaeozoic Khramov & Rodionov (1980), Khramov *et al.* (1974). The Middle to Upper Palaeozoic part of the scale was compiled using rock sample from Russian platform and its margin Khramov (1963) Boronin (1979). Normal-Reversed Polarity zone (NRP), which is considered to indicate the boundary of Kiaman-Illawarra hyperzone, has been recognized in many sections of the eastern Russian platform Boronin *et al.* (1971). The stratigraphical position of this zone is not stable, even in correlable sections, and occurs in different stratigraphical levels Boronin (1979).

The Tatarian stage on the eastern Russian platform consists of sandstones, clays, and carbonate rocks containing fresh water fauna-bivalves and ostracodes (Darwinula). These sediments have been sequenced biostratigraphically, rhythmostratigraphically and magnetostratigraphically. It was possible to distinguish some stratigraphical units and to correlate them on the whole eastern part of the Russian platform from the Sukhoma (North) to the Volga and Vyatka (East) rivers Ignatiev (1962), Boronin (1979).

Lithology and field description

At Monastirskoje (54.8°N; 48.8°E) on the banks of the Volga river, 300 oriented samples have been collected across 150m of a Upper Permian continental sequence of red beds. In the nearby section of Titjuschin where the samples are exposed in a wide fold structure, several sam-

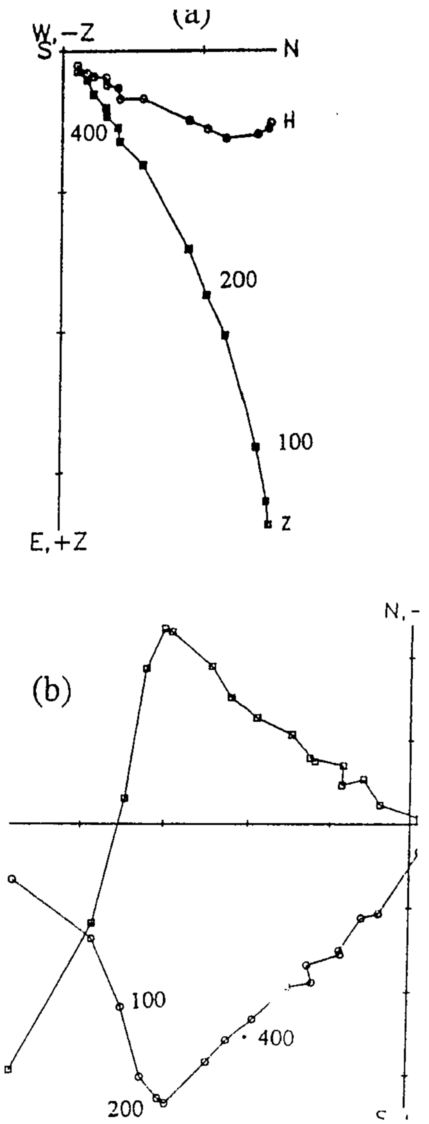

Fig.1 - As-Zijderveld diagramms showing the NRM vectors during the thermal demagnetization. a) positive inclination and b) negative inclination. Orthogonal projections of the NRM horizontal (H) and vertical (Z) components in geographic coordinates.

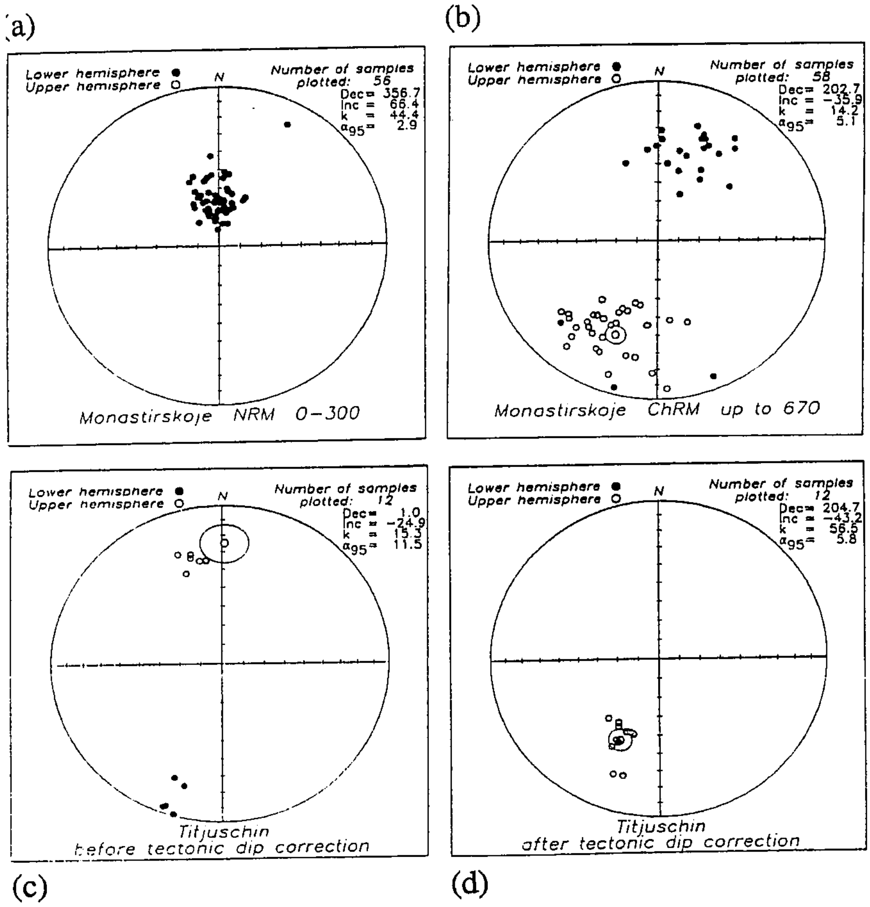

Fig.2 - Stereographic projections of the ChRM directions at Monastirskoje defined belove (a) and up (b) 300°C, after tectonic corretion. Stereographic projections of the ChRM directions at Titjuschin before (c) and after tectonic correction (d). Open and solid circle for upper and lower hemishere respectely.

ples have been collected for a fold test.

The Tatarian here is represented mainly by a rhythmic alternation of red clays and argillaceous siltstones. Thin fresh water limestones and dolomites are interbedded. Sometimes crossbedded sand banks occur.

Depending on the lithology of the soft argillaceous clays and silts or ot the hard limestones and dolomites, respectely oriented cubic samples of 8cc volume were cut by knife or cilindrical 1 inch cores were taken using a drilling machine, respectely.

The fold at Titjuschin (54.6°N; 48.3°E) is formed by red clays interlayered with limestones. The outcrop may represent a synsedimentary tectonic slumping because the underlying Kazanian limestones and the overlying Triassic and Jurassic sediments are in horizontal unfolded position. Alternatively, the dissolution of gypsum contained in the red bed sequence may have caused the fold structures at along several faults in this region which are called "Tetjushi folds" Chepikov & Blom (1967). Their age is said to be Pre-Neogene (Paleogene) because considerable tectonic activity occured during this time Milanovsky (1940). Six hand samples, from which 30 subsamples were obtained, were collected along both sides of a folded outcrop.

Palaeomagnetic measurements

Sixty pilot samples from different stratigraphical high of Monastirskoje section were selected and subjected to a progressive demagnetization procedure both thermal (PTD) from 50°C to 700°C and alternating field (AF) from 5 to 80mT. The natural remanent magnetization (NRM) has been measured after each steps with a three axes cryogenic magnetometer (2G enterprises).

The AF procedure was not sufficient to isolate the primary remanent component. All the samples were therefore demagnetized thermally in 50°C steps and above 500°C the increment was reduced to 30°C. The absence of significant variations of low field magnetic susceptibilities measured by a KLY-2 bridge at each PTD step, ensured us that no modifications were occuring in the magnetic mineral during the heating.

The red marls, clays and argillaceous siltstones characterized by high value of NRM and showed a good stability during thermal treatment. Two components of magnetization were detected in most measured samples (Fig.1a,b).

The low temperature component, removed under 300°C, reflects the actual magnetic field (Fig.2a); the high temperature component, isolated between 350°C and 600°C, represents the primary component characterized either by positive or negative polarity (Fig.2b).

The weak value of the low field susceptibility (10^{-5}, 10^{-6} SI) and the low intensity of the NRM (10^{-4}, 10^{-5} A/m) indicated a low concentration of terromagnetic minerals in the limestone and dolomite samples. Morever the samples with this lithology did not show a stable behaviour during the demagnetization procedure. The remains samples represented by red clays and argillaceous siltstones, were heated in the temperature interval from 350°C to 600°C, which allowed to isolate the primary component .The samples collected at Titjuschin were characterized by a stable NRM showing two components of magnetization. A component removed under 300°C reflects the actual magnetic field. The high component removed upper 350°C represents the characteristic magnetization wich shaws a negative inclination.

Discussion and conclusion

The analyses carried out on the samples at Titjuschin have defined a positive fold test. The mean directions of the primary component were scattered before Applying the tectonic correction (Fig.2c), while the grouping improved significantly after the bedding correction (Fig.2d).

Therefore the fold test indicates that the characteristic magnetization pre-dates the folding, and could be of very early origin if synsedimentary slumping occurred, or at least of pre-Paleogene age if the site was deformed at that time.

The characteristic directions of magnetization obtained by the analysis of the samples collected at Monastirskoje have been plotted as function of profile depth. The lower and the upper part of the profile is characterized by a reversed polarity magnetization, while in the middle part can be distinguished, a normal polarity magnetization except in some levels where short events of reversed polarity magnetization are present (Fig.3).

Therefore, in the magnetostratigraphic profile two reversed and one normal polarity zones are distinguished. In the normal polarity zone about 6 levels are chacaracterized by the presence of samples carryng reversed polarity magnetization, some inversion is recorded just by one sample.

The lower reversed polarity zone may represent the final part of the Kiaman. Therefore, from these preliminary data may result that in the Monastirskoje outcrop is recorded the boundary from Kiaman to the Illawarra superchron which position is still not well defined.

Considering that the application of the local or regional stratigraphic schemes leads to difficulties and apparent diachronous age estimates of the end of the Kiaman superchron, it could be convenient to analyse the stratigraphic and sedimentological situation of the paleomagnetic data carefully and to revise eventually the age relations of the geological schemes according to magnetostratigraphic constraints.

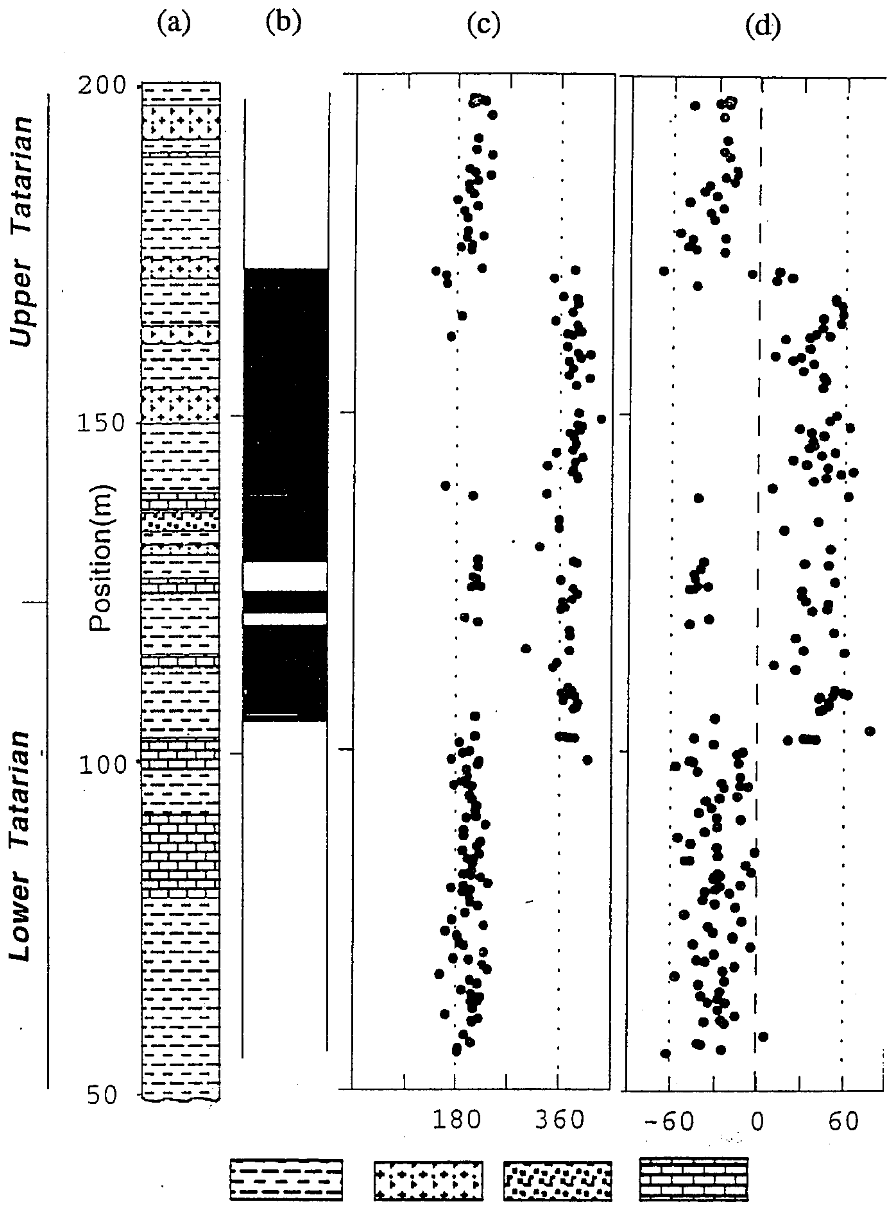

Fig.3 - a) lithologic column of Monastirskoje section 1) merly limestone; 2) sandy clay; 3) cross bedded sandstone; 4) dolomite; 5) red marls. b) magnetostratigraphic section at Monastirskoje. Black = normal ; white = reversed polarity zone. c, d) characteristic directions of magnetization (declination and inclination respectely) plotted as function of profile depth.

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