Magnetostratigraphy of the Neogene Surai Khola Siwaliks in West-Nepal: preliminary results

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Abstract

The aim of this study is magnetostratigraphic age dating of a well exposed 5 500 m Neogene section of molasse sediments in the area of Surai Khola (Siwalik Range of West-Nepal). In this paper first results are presented: two opposite polarities show that the detrital remanent magnetization (DRM) is preserved in the sandstones throughout almost the entire section. Progressive demagnetization and isothermal remanence experiments indicate that the DRM is carried by hematite. Superimposed goethite remanences or viscous remanences can be removed by thermal demagnetization. The preliminary polarity sequence presented in this paper is based on data from the 200 °C demagnetization step. The evaluation of the final result requires further demagnetization and also rockmagnetic analysis.

Introduction

The Siwalik Range is formed by Miocene to Pleistocene molasse sediments to the south of the Himalayas. Since 1983 geological, lithological and biostratigraphic investigations have been in progress in the Surai Khola area of West-Nepal (fig. 1) (Corvinus 1988). The study is concerned with a continuous well exposed sedimentary section of about 5 500 m thickness. Age dating by biostratigraphic and radiometric methods is not possible. Magnetostratigraphy may be an adequate tool for dating the sediments. Successful applications of magnetostratigraphy in other areas of the Siwalik Range are reported by Johnson et al. 1982, Tauxe and Opdyke 1982, Johnson et al. 1983, Burbank and Johnson 1983 and Tokuoka et al. 1986.

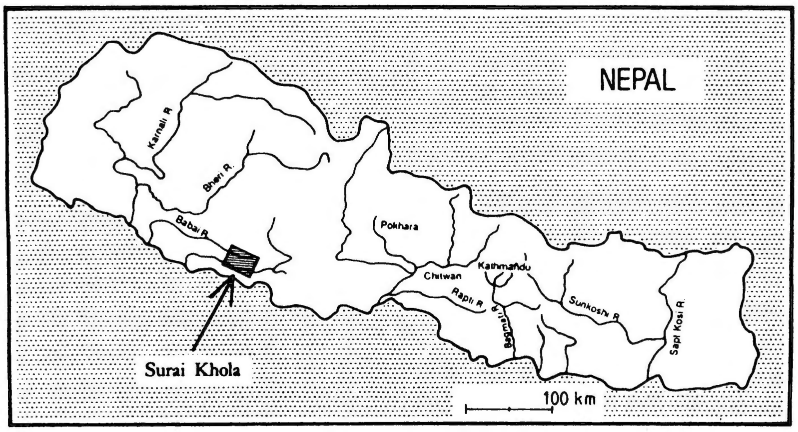

Fig. 1. Map of Nepal with investigated area of Surai Khola.

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Geology and lithology of the Surai Khola section

The sequence of the Surai Khola section (see fig. 6) consists of tilted sediments (60–70° northward dipping, WNW-ESE striking) without any major tectonic disturbances. It represents a continuous record of fluvial sedimentation in the Neogene period. The section is composed of interbedded conglomerates (mainly in the upper part), sandstones, clays, shales and siltstones. The grain size of the sandstones coarsens from the lower to the upper part of the section. A stratigraphic subdivision into 6 units (Bankas, Waterspring, Chor Khola, Surai Khola, Dobatta and Dhan Khola Beds) is proposed by Corvinus 1988.

Paleomagnetic and rockmagnetic analysis

More than 600 orientated sandstone samples were drilled across the entire section. Only 20 of them are from the mainly conglomeratic Dhan Khola Beds at the top of the section. In order to obtain a better resolution, 80 additional orientated clay samples were collected there. The clay samples show inconsistent demagnetization behaviour and their interpretation requires further detailed analysis. Therefore this paper is limited to discussion of the sandstones.

Despite lithological differences (e.g. grain size and colour) between the sandstones within the section, their demagnetization behaviour is reasonably similar. The natural remanent magnetization (NRM) is found to be stable when alternating field demagnetization is applied. Different remanence components can be obtained from thermal demagnetization. For thermal treatment a shielded Schonstedt furnace was used. Remanence measurements were carried out using a cryogenic magnetometer (LETI RS 01). Generally the NRM intensities (0.11 mA/m – 31.8 mA/m) – even after demagnetization – were sufficiently above the noise level of the magnetometer (about 0.01 mA/m).

Isothermal remanent magnetization (IRM) acquisition and thermal demagnetization of an IRM (fig. 2) reveal two magnetic phases with high coercivity: hematite and goethite. Hematite can be found in all sandstones, whereas the amount of goethite varies considerably. Frequently a magnetic component with lower coercivity, probably magnetite (or maghemite), occurs.

Sandstones with hematite as the main magnetic carrier show only a single remanence component upon thermal demagnetization from the NRM up to the Curie temperature of hematite (fig. 3, sample 74–99). Chemical remanent magnetizations (CRM) carried by goethite can be eliminated by thermal treatment at 100 °C (fig. 3, sample 46–03). Viscous remanent magnetization (VRM), probably carried by magnetite (or maghemite), can also be removed by thermal demagnetization (fig. 3, sample 245–01), but higher temperatures may be required (fig. 3, sample 48–01).

The demagnetization test series and IRM experiments of 16 pilot samples show that the remanence component carried by hematite is expected to be the carrier of a primary magnetization.

The bedding corrected NRM data (fig. 4) show two opposite directions, indicating that a detrital remanent magnetization (DRM) is preserved in the sandstones. A considerable inclination error* of 20—30° is obvious, a phenomenon which is also found by other authors in comparable sections of the Siwaliks (Tauxe and Opdyke 1982; Johnson et al. 1983). Due to this inclination error, the core corrected normally polarized DRM directions (fig. 4) are rather close to the present dipole field of the Surai Khola area (inclination + 47°). Doubtless, the reverse NRM polarities represent the DRM, but the numerical dominance of NRM directions with apparently normal polarity suggests that a VRM or CRM is superimposed on the DRM.

* Inclinations are flatter than expected (frequently observed in sediments).

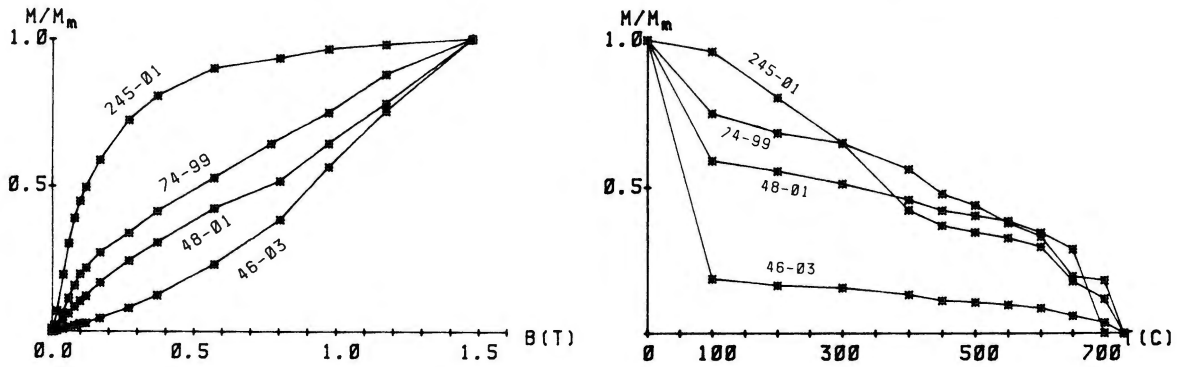

Fig. 2. Isothermal remanent magnetization (IRM) acquisition curves and thermal demagnetization of IRM (normalized curves).

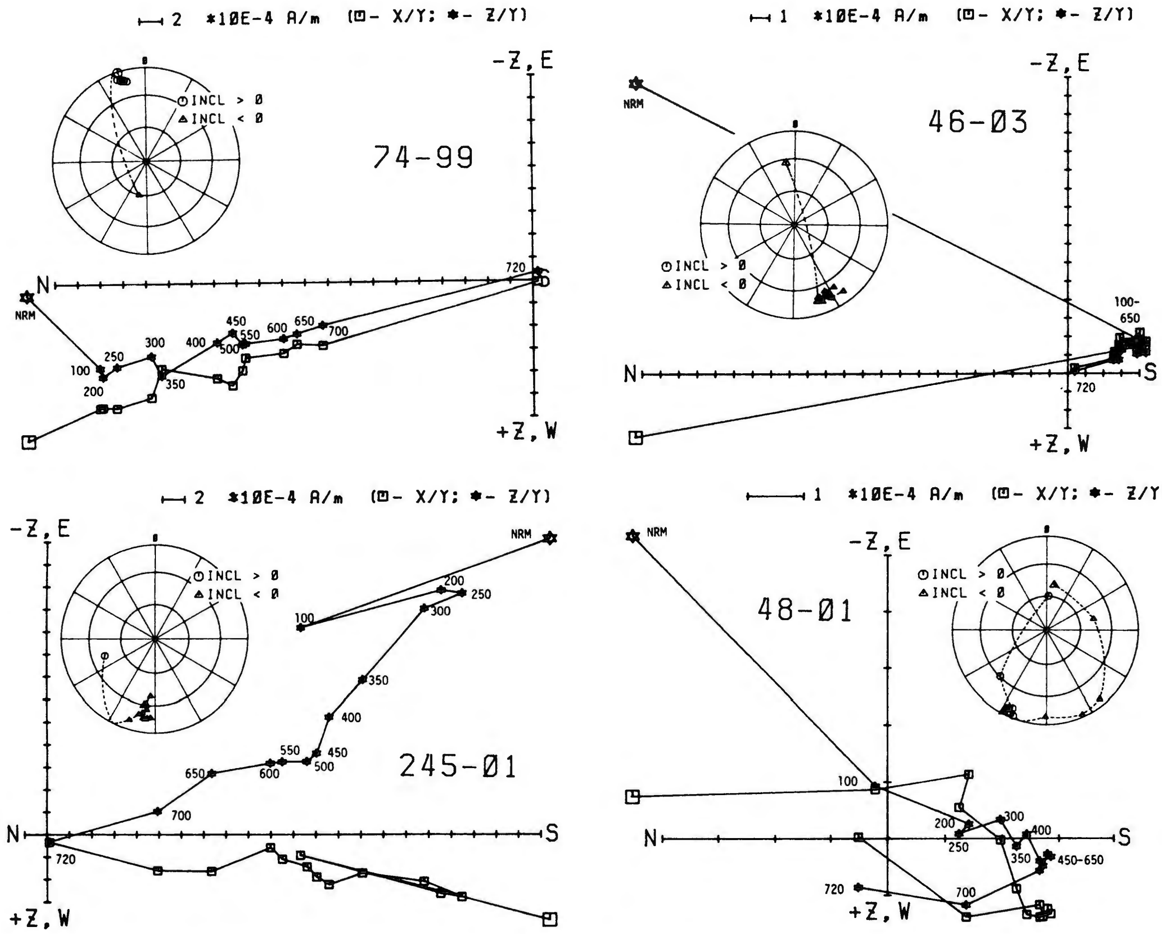

Fig. 3. Orthogonal vector projection of the horizontal and vertical remanence direction (large plots) and equal area projection (small plots; bedding corrected) of thermal demagnetization of pilot samples. Demagnetization temperatures (°C) are given. The samples are the same as those shown in fig. 2.

At this stage of our investigations thermal demagnetization within the entire section has been carried out at 200 °C only. After demagnetization about half of the samples change their direction by less than 10° compared with the NRM. For these samples the grouping of the normal and reverse polarity directions (fig. 5) is far better than for the bedding corrected NRM directions of all samples. However,

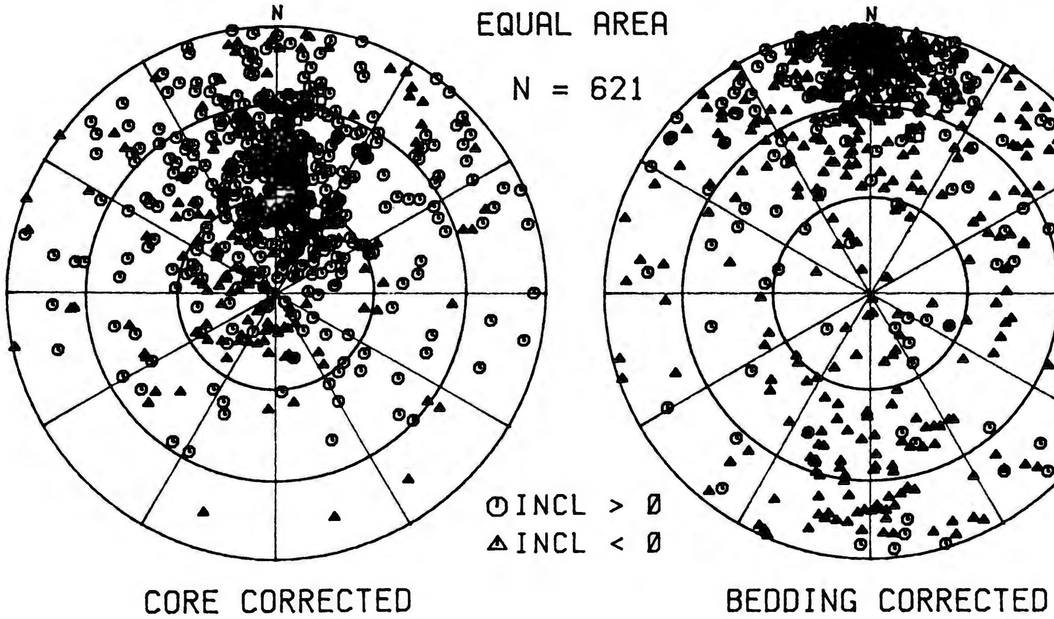

Fig. 4. Equal area projection of natural remanence directions of all sandstone samples.

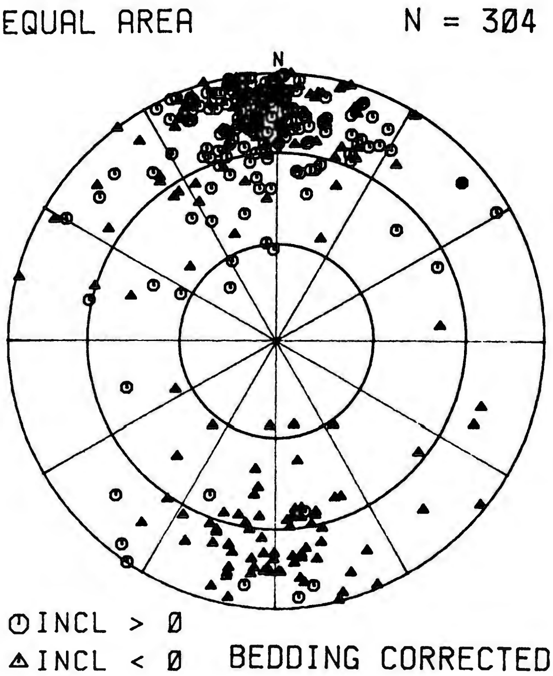

Fig. 5. Equal area projection of remanence directions after 200 °C thermal demagnetization. Only samples showing direction changes < 10° against the NRM value are included.

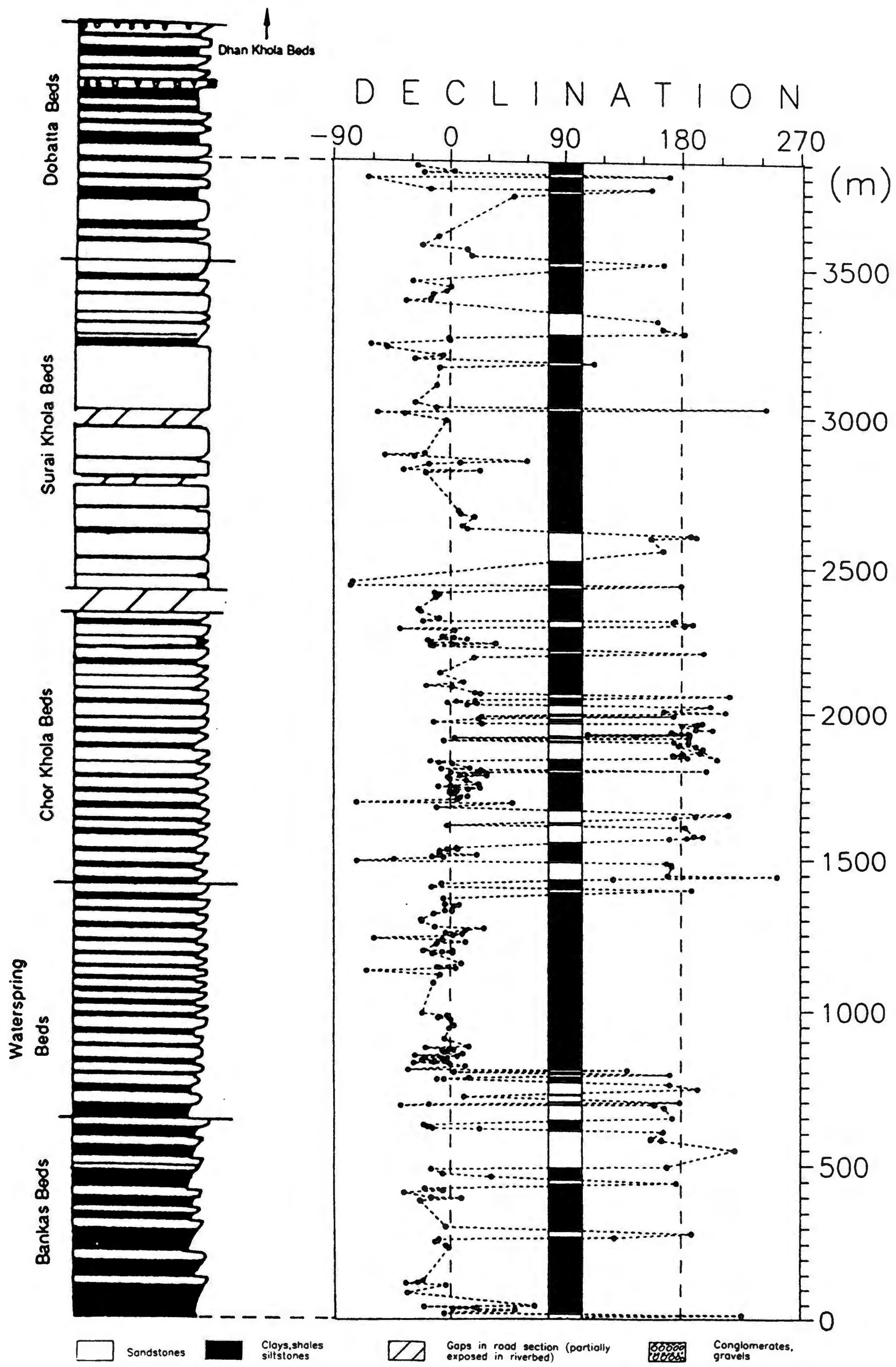

Fig. 6. Lithology, declinations (0: north, 180: south) and polarity sequence of the Surai Khola section. Only samples from fig. 5 are included. Black: normal polarity, White: reverse polarity.

the number of normally polarized samples exceeds the number of reversely polarized samples by a factor of 3. Two explanations can be given for that: in some of the normally polarized samples the VRM may not yet have been removed. Furthermore, two thirds of the samples not included in fig. 5 seem to have a reverse magnetization, which is still overprinted by a VRM at 200 °C.

Polarity sequence

The preliminary magnetostratigraphic result is shown in fig. 6. The interpreted polarity sequence is better confirmed between 0 and 2 500 m than above 2 500 m. Results from the Dhan Khola Beds are not presented because of the lack of data from the clay samples. In order to establish the final polarity time sequence and to date the section by comparison with the standard polarity time scale, further demagnetization and rockmagnetic analyses are in progress.

Acknowledgements

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