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Magnetic properties of oil sand at El Borma; Paleomagnetic dating of oil emplacement.

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Palaeomagnetism may help in improving the stratigraphic resolution of a sedimentary sequence if a number of requirements are fullfilled:

1) The magnetisation must be localised in minerals whose origin can be determined. If the magnetisation is carried by detrital minerals, the time of deposotion may be determined. If it is carried by secondary, diagenetic minerals the diagenetic event may be dated. One problem in palaeomagnetic studies is the correct interpretation of which minerals that are carrying the remanent magnetisation.
2) The sampled material must have been protected from later magnetic changes, such as the precipitation of new magnetic minerals (e.g. hematite or sulphides), and/or dissolution of primary magnetic minerals.
3) The samples must be geographically oriented, either during sampling or by the magnetic data, so that the primary magnetism found during the demagnetisation analysis can be correlated to an apparent palaeopole curve for the relevant area.. In exceptional cases where very long sequneces are sampled, it may be sufficient to establih a polarity scale which can then be matched to the established polarity time scale for the relevant area.

Fortunately the magnetic analysis carried out in the laboratory can in itself give some indication of which mineral(s) that is carrying the remanent magnetisation. The presence of these minerals may then be verified by the use of other technics, primarily thin section analysis and EM analysis. In addition, some theoretical considerations should be carried out to evaluate whether the proposed mineral paragenesis is plausible for the studied sequence.

One of the difficulties when studying oil reservoir sequences is that the oil migration severly changes the diagenetic environment, first of all the Eh and pH conditions. The reducing conditions established by the migration processes will lead to dissolution of important magnetic carriers such as hematite. Depending on the depth of burial and the level of sulfur introduced to the sediments, highly magnetic monosulfides (greigite and pyrhotite) may be formed and remain stable, disseminated throughout the sediment. If the oil migration and associated geochemical changes occur over a long time period during which the geomagnetic field changes polarity several times, the apparent paleopole will be blurred. Contrarily, if the migration and oil emplaceent happened over a shorter time period, the diagenetic monosulphides will show the correspondent geomagnetic direction and dating of the oil emplacement should thus be possible by a magnetic analysis.

The present study of the El Borma reservoir was originally conducted with the purpose to establish a reference geomagnetic polarity scale. The result is shown in fig.1. A general agrement with standard logs was found to be apparent and it thus appears to be a good reference scale for other cores in the field. The sequence is, however too short to give an unambiguious correlation with the global polarity scale. The best use of these results is thus as a correlation tool.
Some samples were taken from oil soaked sandstones. These provide the opportunity to investigate the special magnetic characteristics of the oil sands compared to the sandstones without oil. In addition, it provides the possibility for dating the oil emplacement if the primary iron oxides were dissolved and new magnetic minerals were formed during a relatively limited time period.

In fig.2 the mean direction of the stable remagnetisation of 5 oilsamples is shown compared with the mean direction of oil free sandstone. The mean directions shows a steeper direction than the oilfree samples. This corresponds to a younger age and may thus be interpreted as indicating the age of the oil emplacement. Unfortunately the time-resolution of the APWP is rather poor for North Africa, since the movement of the continent during most of the Mesozoic consisted of rotation and not longiutudinal movements which are required to give a good time resolution of the directions. However, the results show the potential of palaeomagnetism in determination of the diagenetic event (oil emplacement) and it may be that the ongoing processing of the remaining oil stained samples will lead to a more exact dating of the oil emplacement.

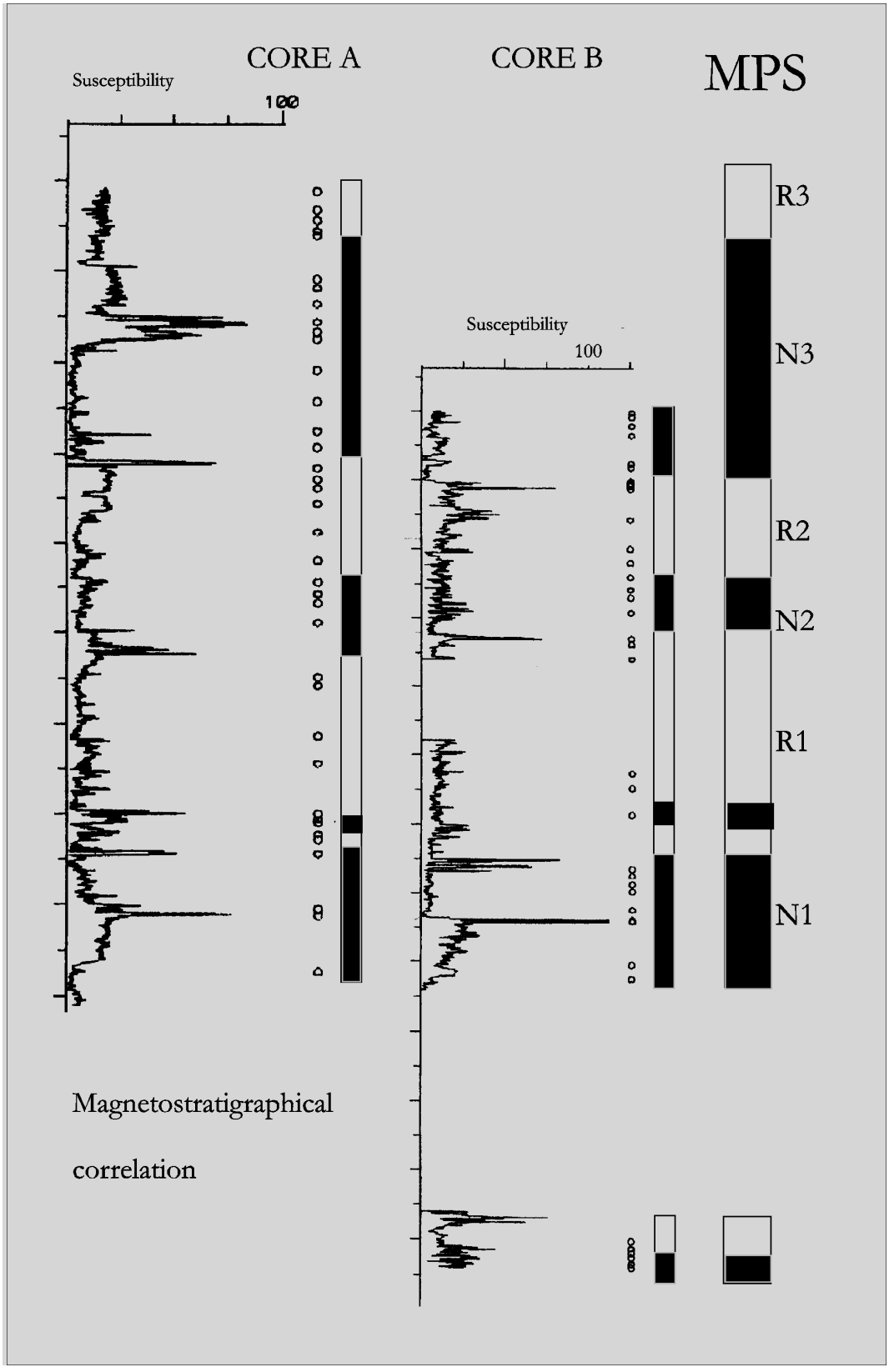
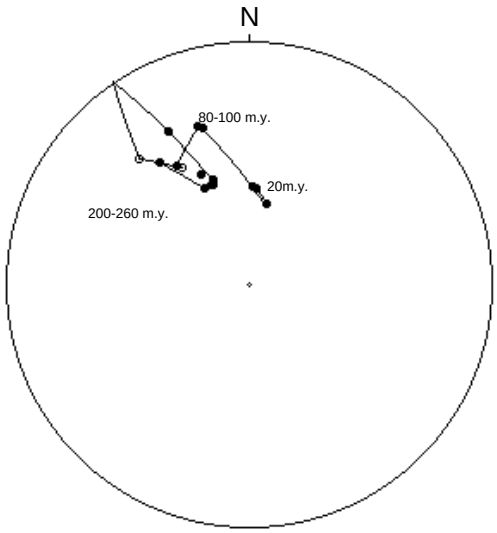

CORE A
CORE B
MPS
Susceptibility
100
Susceptibility
100
R3
N3
R2
N2
R1
N1
Magnetostratigraphical
correlation

Fig.1



expected directions and corresponding ages.

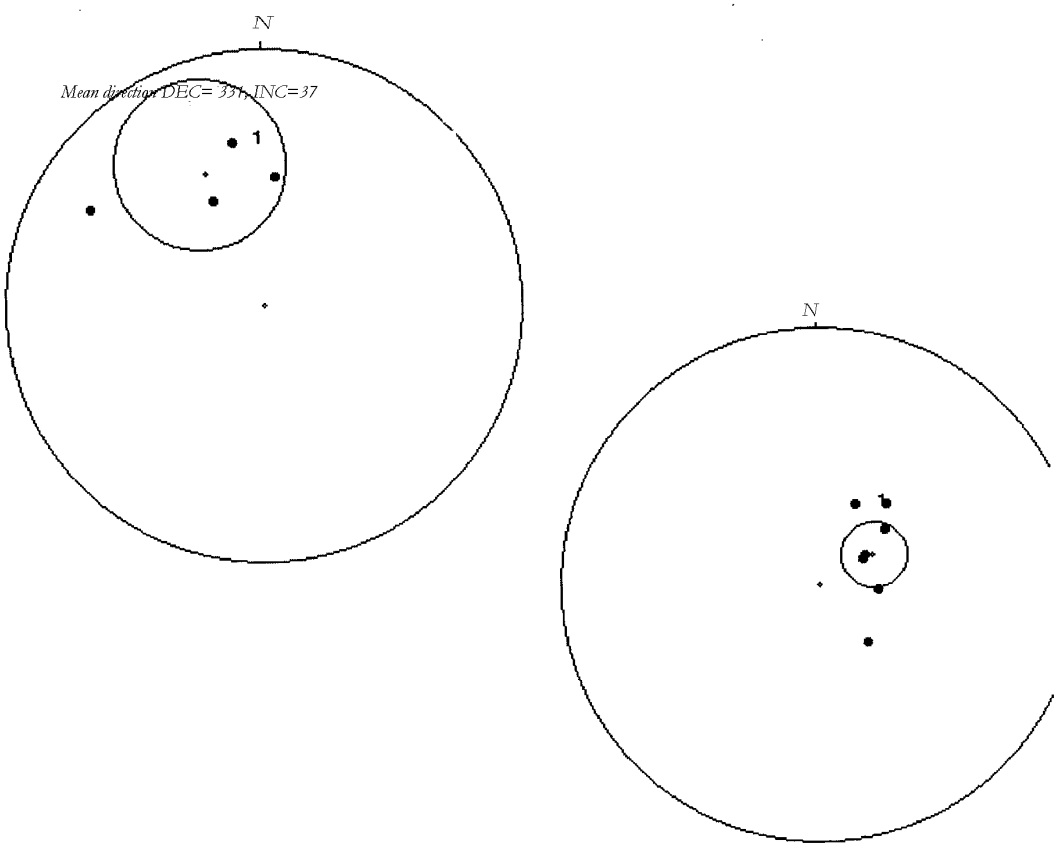


Fig.2
The expected directions for corresponding ages (top) plotted in sterographic projection. It is seen that the Tertiary, Cretaceous and Triassic-Jurassic directions are not easily distinguished. Below the primary directions of oilfree samples (left) and of oil soaked samples (lower right).