For purpose of comparison, we then reconstructed changes in the land/ocean ratio and of vegetation cover since Devonian times to calculate variations of the Earth's albedo. In geologic history, cooling took place in times when large continents were shifted to high latitudes and the Earth's albedo was high. The building of ice caps as during the Permo-Carboniferous increased the Earth's albedo and in turn cooled down the Earth. In addition, the cooling must have lowered the atmospheric content of water vapor and hence reduced the total greenhouse effect. Using an energy balance approach, we calculated changes of the Earth's temperature and deduced changes of the atmospheric water vapor content. We found that during cool periods high pCO_2 was more than compensated by low water vapor content of the atmosphere. We therefore infer from our model that over long geological periods continental drift is the driving force for climatic variations.

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CC03 : WEpm38 : G2
Is High Obliquity a Possible Mechanism to Explain Tropical Glaciation at Neoproterozoic?

Ramstein Gilles (ramstin@lsce.saclay.cea.fr)[1],
Donnadieu Yannick[1],
Laskar Jacques (jacques.laskar@bdl.fr)[2],
Fluteau Frederic (fluteau@ipgp.jussieu.fr)[3] &
Besse Jean (besse@ipgp.jussieu.fr)[3]
[1] Laboratoire des Sciences du Climat et de l'Environnement, DSM/Orme des Merisiers/Bat 709, 91191 Gif sur Yvette, France
[2] Astronomie et Systemes Dynamiques/ Bureau des Longitudes, 77 Av. Denfert-Rochereau, 75014 Paris, France
[3] IPGP, T24-25, E1, 4 Place Jussieu, 75252 Paris Cedex 05, France

One possible mechanism that can be invoked to explain low-latitude glaciation in the Palaeoproterozoic era is an high value of the Earth obliquity. On one hand, Williams et al. (1998) have suggested that "climate friction" could have caused the obliquity to shift from high values to low values (as for present day). On the other hand, Laskar et al. (1993) have shown that for low obliquity values, the effect of the moon implies stability of the Earth obliquity in a narrow band (as for present day), but the behaviour is chaotic for high obliquity (from 60 to 90°). We have investigated using the response of an AGCM high obliquity scenarios for explaining tropical glaciation. Because high obliquity enhances seasonality, it can lead to the melting of ice cover, therefore, it is important to test the consistency between 90° obliquity scenario and Proterozoic glacial climate.

Williams DM, Kasting, JF & Frakes LA, *Nature*, **396**, 453-455, (1998).
Laskar J, Joutel F & Robutel P, *Nature*, **361**, 615-617, (1993).

Wednesday PO Session

CC03 : WEpo01 : PO
Astronomical Forcing in Late Eocene Sediments: Using XRF Data from ODP Leg 171B Site 1052

Heiko Paelike (hpal98@esc.cam.ac.uk)[1],
Nicholas J Shackleton (njs5@cus.cam.ac.uk)[1] &
Ursula Roehl (uroehl@allgeo.uni-bremen.de)[2]
[1] Godwin Institute, Dept. Earth Sciences, New Museum Site, Pembroke Street, Cambridge, U.K.
[2] Universitaet Bremen, FB-5 Geowissenschaften, Klagenfurter Strasse, D-28359 Bremen, Germany

Recently the astronomically calibrated geological timescale has been extended to the base of the Oligocene (Shackleton et al, 1999). Here we present a new relative age calibration of sediments of late-Middle Eocene (39.5 Ma) to Late Eocene age (35 Ma) that were obtained from deep-marine sediment cores during ODP Leg 171B from Site 1052. We analyse elemental ratios of Fe and Ca as a proxy for calcium carbonate content, obtained by using an X-ray Flourescent Scanner (XRF). Our data match very well with other proxy data (magnetic susceptibility and colour reflectance) but show a significantly higher signal-to-noise ratio and a more consistent hole-to hole agreement. The data obtained hence allow the construction of a more accurate composite depth scale.

The data display a strong orbital signal that shows variability at all major Milankovitch frequencies. We use the eccentricity driven amplitude modulation of precession to put our record onto a relative timescale, assuming that the 400 kyr eccentricity cycle has been stable at that time (Laskar, 1999). The exact nature of the orbital signal might be subject to revision pending further calculations, but the consistent relationship between the different orbital frequencies present in the data suggests new ages for Magnetochrons C16, C17, and C18 that will refine the magneto-stratigraphic timescale created by Cande and Kent (1995). Our astronomical calibration suggests that the relative durations of these magnetochrons has not changed significantly, although the absolute ages might be ~200 ky younger than on the Cande and Kent timescale. Our study should allow a better time control for high-resolution studies over the late Eocene time interval.

Shackleton NJ, Crowhurst SJ, Weedon GP & Laskar J, *Phil. Trans. R. Soc. Lond. A*, **357**, 1907-1929, (1999).
Laskar J, *Phil. Trans. R. Soc. Lond. A*, **357**, 1735-1759, (1999).
Cande SC, Kent DV, *J. Geophys. Res*, **100**, 6093-6095, (1995).

CC03 : WEpo02 : PO
Discovery of the Northernmost Gondwanian Evidence of an Upper Ordovician Glacier: Southern Turkey

Jean François Ghienne (ghienne@illite.u-strasbg.fr)[1],
Hüseyin Kozlu (hkozlu@petrol.tpao.gov.tr)[2],
William T. Dean[3],
Yilmaz Günay (ygunay@petrol.tpao.gov.tr)[2] &
Olivier Monod (olivier.monod@univ-orleans.fr)[4]
[1] EOST, 1 rue Blessig, 67084 Strasbourg, France
[2] TPAO Exploration G., M.Kemal Mah.2 Cad#86, 06520 Ankara, Turkey
[3] Nat. Mus. Wales, Dept. Geology, Cardiff CF1 3NP, U.K.
[4] ISTO, Université d'Orléans, 45067 Orléans, France

Although evidence for the latest Ordovician (Hirnantian) glaciation is well documented from western Africa to Arabia, the maximum extent of grounded ice in northern Gondwana has always been elusive. Recent investigations in the Taurus chain of southern Turkey now demonstrate that glaciers extended northwards much farther than previously expected.

The existence of glacially-related sediments in southern Turkey was suspected following the identification of conglomeratic sandstones at the Ordovician-Silurian boundary. However these conglomerates were generally considered as forming the basal part of the Silurian formations. Closer examination of several lower Palaeozoic successions in Anamur, Silifke, Adana and Mardin provinces locally demonstrates the presence of the glacier itself in late Ordovician times. The glacial nature of the deposits is shown by numerous isolated pebbles and cobbles of exotic origin (granite, orthogneiss, aplite, rhyolite, quartz) which are embedded in diamictites or sandy shales, and exhibit typical planar striated faces.

The extension of grounded ice in southern Turkey is demonstrated by a striated pavement upon structureless diamictites that contain in situ striated pebbles bearing the same orientation. In Adana province, the latest Ordovician succession suggests a prograding submarine fan in contact with ice (glacial maxima), followed by dropstone-bearing distal glaciomarine shelf deposits (deglaciation). Trilobites of early Ashgill age are present in the underlying siltstones, and overlying black shales are dated as Llandovery by means of graptolites. These relationships suggest that, in southern Turkey, only a minor (if any) sedimentary hiatus is associated with the glacio-eustatic sea level lowstand.

This sequence displays strong affinities with coeval glacial successions in North Africa (Algeria, Morocco), Iberia and Sardinia. Global reconstructions generally agree in locating southern Turkey along the Egyptian-Libyan coastline. At present, southern Turkey appears to be the northernmost part of the Gondwana platform covered by late Ordovician ice.

CC03 : WEpo03 : PO
The use of Organic Matter and Clay Minerals Study to Define the Selli Event (Konhora Fm., Western Carpathians, Slovakia)

Julia Kotulova (kotulova@savbb.sk)[1],
Adrian Biron (biron@savbb.sk)1[2],
Otilia Lintnerova (lintnerova@fns.uniba.sk)[2] &
Jozef Michalik (geolmich@savba.savba.sk)[1]
[1] Geological Institute, Slovak Academy of Sciences, Severna 5, 974 01 Banska Bystrica, Slovak Republic
[2] Faculty of Natural Sciences,Comenius University, Mlynska dolina 1, 842 15 Bratislava, Slovak Republic

Lower Aptian sediments of the Konhora Formation in the Rochovica section represents an intercalation of black shales in pelagic majolica-type limestones of the Pieniny Klippen Belt. Detail C-isotope stratigraphy allows to determine the "Selli Event" in the anoxic part of the Konhora Fm (Lintnerova et al. 2000). Three transgessive/regressive cycles are recognizable in ca 6-7 meters thick sequence. Sedimentary organic matter sensitive reflects these small-scale fluctuations. Study of quantitative and qualitative distribution of organic matter in the Konhora Fm. provides the following identifications: 1. Organic matter (OM) content reaches the maximum (TOC = 0.68 - 0.71 wt%) in the initial phase of transgessive cycle. Increase of TOC content due to transgression is even more expressed under anoxic conditions of sedimentation (TOC = 1.39 - 3.23 wt%). 2. Two main types of sedimentary OM are present in shales: marine (alginite) and terrestrial kerogene derived from land vegetation (vitrinite, liptinite, fusinite, sporinite). Anoxic part of study section is markedly anomalous from other parts, having a considerably greater quantity of both OM types, smaller forms of alginites, prevalence of liptinite over vitrinite, predominance of "relative fresh" (non-oxidized particles) above oxidized terrestrial OM. 3. Lowermost OM contents occur in condensed parts of the section, linked with maximum flooding surfaces (TOC = 0.45 wt%). Characteristic feature is occurrence of pure inertinite and fusinite particles (oxidized OM). Microscopical observations fit well with the Rock-Eval pyrolysis data, giving the lower HI values in the condensed parts (44 mg HC/g Corg) and substantially higher HI values in other parts (296 mg HC/g Corg). Within the sequence studied, no systematic variations in contents of clay minerals have been observed. The clay fractions consist of discrete illite + I/S, corrensite-like mixed-layered chlorite/smectite or chlorite/vermiculite and chlorite with average ratio of 7:2:1. The more expressive change of smectite content in I/S was recorded in bed 409: an abrupt increase from 20-25% S to 40-50% S, which persists up to bed 437. This is also accompanied by a decrease of degree of ordering in the I/S from R1 to R0 or R0.5. As the burial effect is not considered here, sudden change of I/S properties might be related to the change of provenance of siliciclastic material and/or change of climatic conditions during deposition. The Konhora Formation "anoxia" gave rise due to the Lower Aptian greenhouse. During the greenhouse, the nutrification and overproduction, as well as continental runoff of terrestrial plants led to oxygene depletion and anoxicity of water mass. Therefore, the organic matter study closely correlate with positive isotope excursion within the Selli Event of the Konhora Fm.

Lintnerova O, Michalik J, Wissler L, Biron A & Kotulova J, *Slovak Geol. Mag*, **6, 2-3**, 231-233, (2000).