GTSnext – activities in the Netherlands

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Project IV.2: Interlaboratory biases and first principles calibration of Three of the 12 GTSnext projects are based in the Netherlands (see figure 1).

Time Scale with unprecedented accuracy, precision and resolution

GTSnext - Towards the next generation of the Geological Time Scale for the last 100 million years

80
60
40
20

response.

correct phase relations between astronomical forcing and climate unravel phase relations between astronomical forcing and climate

ellipticity (E

scale for the Neogene

Aim

quantitatively extract argon from sanidine


Ar

Ar standards


Ar dating to provide precise age constraints on the astronomical tuning of cyclic pre-Neogene successions. This new timescale can then be directly applied to assess fundamental aspects of Earth’s history, such as seafloor spreading rate histories and the potential role of long-period orbital climate forcing. Bentonites in magnetostratigraphically-constrained sections in the Western Interior Basin (USA and Canada) spanning the K-T boundary and early Paleogene will be re-dated to confirm and/or improve existing astronomical tuning. Several ash layers were sampled in the USA in October. Air fall ashes from Toadstool Park (NE Nebraska, see figure 5) and Flagstaff Rim (SE Wyoming, see figure 4) contain both large K-feldspar crystals (for single-crystal 

Ar/

Ar dating) and zircon (for U/Pb dating). The samples are being prepared at the VU Amsterdam and will be distributed within GTSnext 

Ar/

Ar laboratories for interlaboratory bias assessment.

Figure 4: overview of the Flagstaff Rim section

Project II.2: New 

Ar/

Ar constraints for the Paleogene Time Scale

Aim of this task is to focus on the early Paleogene time interval for which a tuned timescale is presently being developed. GTSnext Paleogene projects specifically aim to provide tight constraints for the tuning of the Paleogene, and to intercalibrate the ages provided by each of the separate dating techniques (Ar/Ar, U/Pb).

This task concentrates on recalibrating the Paleogene timescale using 

Ar/Ar dating to provide precise age constraints on the astronomical tuning of cyclic pre-Neogene successions. This new timescale can then be directly applied to assess fundamental aspects of Earth’s history, such as seafloor spreading rate histories and the potential role of long-period orbital climate forcing. Bentonites in magnetostratigraphically-constrained sections in the Western Interior Basin (USA and Canada) spanning the K-T boundary and early Paleogene will be re-dated to confirm and/or improve existing astronomical tuning. Several ash layers were sampled in the USA in October. Air fall ashes from Toadstool Park (NE Nebraska, see figure 5) and Flagstaff Rim (SE Wyoming, see figure 4) contain both large K-feldspar crystals (for single-crystal 

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Ar laboratories for interlaboratory bias assessment.

Figure 5: stratigraphy and fossil abundance of the Toadstool Park section

Project I.1: Perfecting the tuned time scale

Aim of this task is to establish a refined astronomical-tuned time scale for the Neogene by constraining exact values of dynamical ellipticity (Eo) and tidal dissipation (TD) in the astronomical solution. The determination of these values is crucial if one aims to unravel phase relations between astronomical forcing and climate response. The time scale will directly be applied to determine correct phase relations between astronomical forcing and climate response.

Progress and ongoing work:

1) We gained (volumetric) magnetic susceptibility and colour scans at the ODP core redepository Bremen. These data are compared to discrete susceptibility measurements.

2) In order to gain high resolution colour data from these colour scans we have to remove the dark values of cracks. We programmed a routine to analyse the cores and grey scale data and exclude cracks using different methods (see figure 2). We apply this tool to gain high resolution colour time series of ODP site 926 cores (see figure 3). Then this data will be used to constrain the values of Eo and TD.

Figure 2: crack recognition and removal from data

Figure 3: depth series of ODP Leg 154 site 926 core C 28

Project IV.2: Interlaboratory biases and first principles calibration of 

Ar/

Ar standards

First Principles Calibration of 

Ar/

Ar standards

The aim of this project is to calibrate 

Ar/

Ar geochronological standards using the K-Ar method. This involves determining the absolute concentration (moles/gram) of both radiogenic 

Ar and 

K in the standard mineral. Although weight percent 

K is relatively simple to measure, noble gas mass spectrometers typically measure ratios rather than absolute concentrations. Here, we attempt to construct a calibration system for a noble gas mass spectrometer that will enable such absolute measurements (see figure 6).

Previous first principles calibrations from the 1960s and 1970s have used minerals such as biotite, from which it is relatively simple to quantitatively extract argon by heating, but which is known to have problems with argon retention over geologic time. Sanidine, which is the mineral now most commonly used as a standard, has thus far never been successfully calibrated from first principles. Modern induction furnaces and lasers should be able to quantitatively extract argon from sanidine crystals.

Figure 4: overview of the Flagstaff Rim section

Figure 5: stratigraphy and fossil abundance of the Toadstool Park section

Figure 6: experimental setup for the 

Ar/

Ar measurements

Potassium-Argon (K/Ar) Age Equation:

\[ t = \frac{1}{\lambda} \ln \left( 1 + \frac{40 \text{Ar}^*}{40 \text{Ar}} + \frac{40 \text{Ar}}{40 \text{Ar}^*} \right) \]

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