GTSnext – activities in the Netherlands

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

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The **principal scientific objective** of the network is to **establish the next generation standard Geological Time Scale with unprecedented accuracy, precision and resolution** through integration and intercalibration of state-of-the-art numerical dating techniques.

Three of the 12 GTSnext projects are based in the Netherlands (see figure 1).

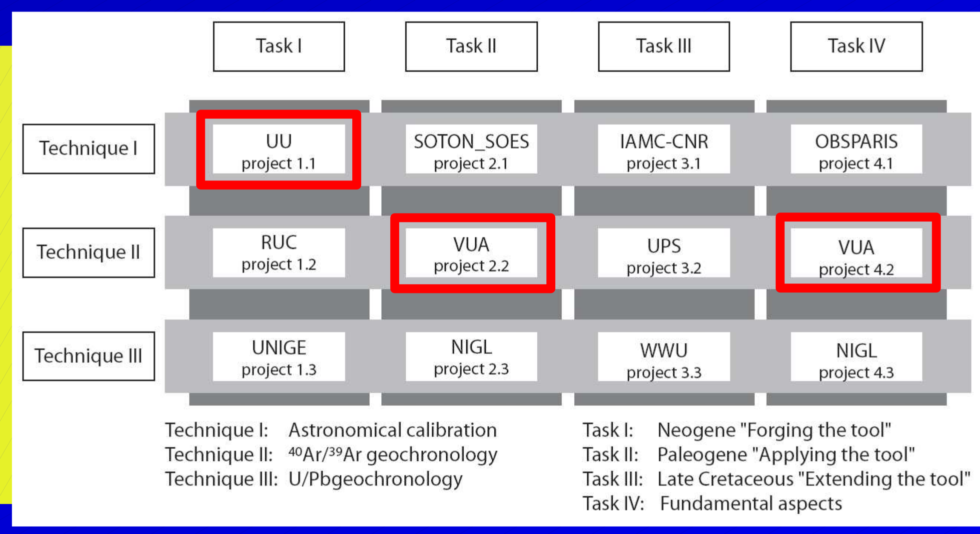

Figure 1: Structure of the GTSnext project

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 (E_D) 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.

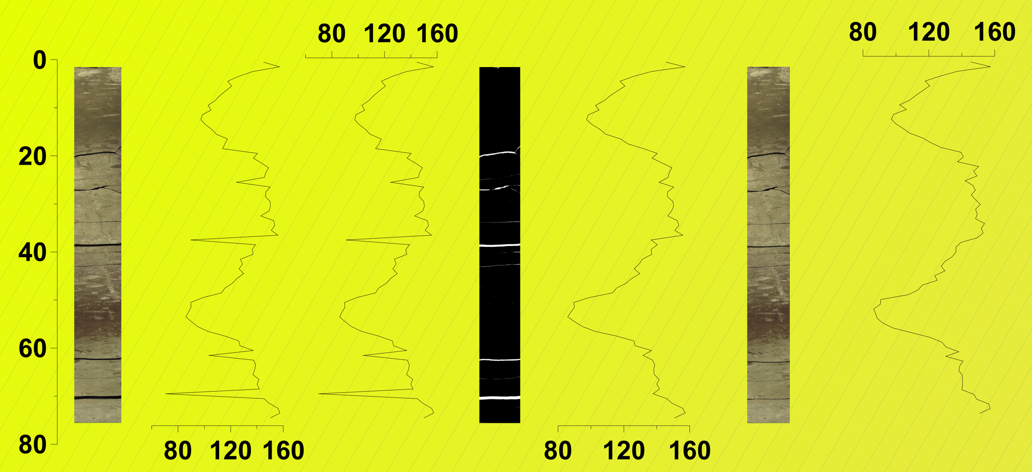

Figure 2: crack recognition and removal from data

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 for colour- and grey scale data and exclude cracks using different methods (see figure 2). We appy 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 vales of E_D and TD.

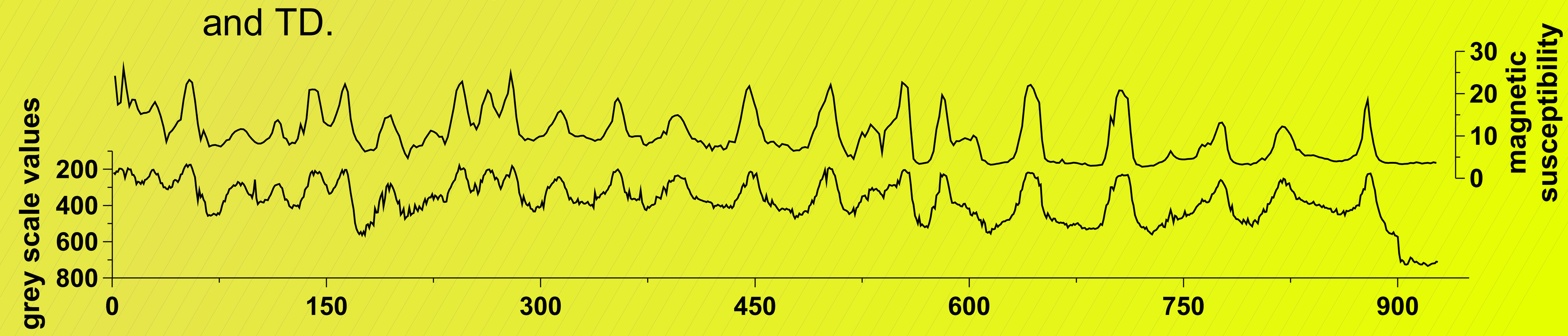

Figure 3: depth series of ODP Leg 154 site 926 core C 26

Project II.2: New $^{40}Ar/^{39}Ar$ 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 $^{40}Ar/^{39}Ar$ 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 Paleocene 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 (NW Nebraska, see figure 5) and Flagstaff Rim (SE Wyoming, see figure 4) contain both large K-feldspar crystals (for single crystal $^{40}Ar/^{39}Ar$ dating) and zircon (for U/Pb dating). The samples are being prepared at the VU Amsterdam and will be distributed between GTSnext $^{40}Ar/^{39}Ar$ laboratories for interlaboratory bias assessment.

Figure 4: overview of the Flagstaff Rim section

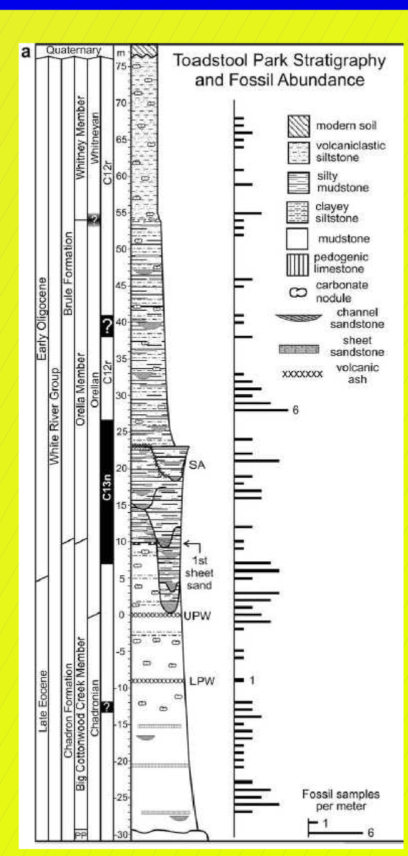

Figure 5: stratigraphy and fossil abundance of the Toadstool Park section

Project IV.2: Interlaboratory biases and first principles calibration of $^{40}Ar/^{39}Ar$ standards

First Principles Calibration of $^{40}Ar/^{39}Ar$ standards

The **aim** of this project is to **calibrate $^{40}Ar/^{39}Ar$ geochronological standards using the K-Ar method**. This involves determining the absolute concentration (moles/gram) of both radiogenic ^{40}Ar and ^{40}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.

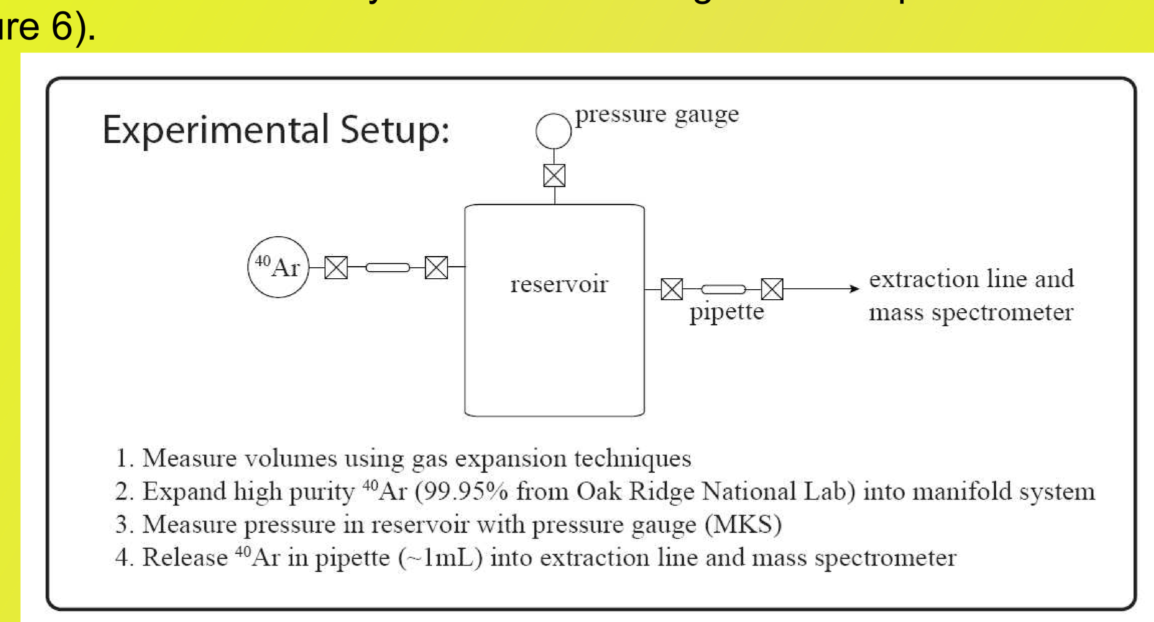

Figure 6: experimental setup for the $^{40}Ar/^{39}Ar$ measurements

Potassium-Argon (K-Ar) Age Equation:

$$t = \frac{1}{\lambda} \ln\left(1 + \frac{\lambda}{\lambda_e + \lambda_{e'}} \frac{^{40}Ar^*}{^{40}K}\right)$$

$^{40}Ar/^{39}Ar$ Age Equation:

$$t = \frac{1}{\lambda} \ln\left(1 + J \frac{^{40}Ar^*}{^{39}Ar_K}\right)$$

$J \propto$ neutron flux during irradiation and is dependent on standard age

Figure 7: equations for the age determination

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