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ESR dating of Neogene marine sands from the southern North Sea basin, NE Belgium: first results

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Quantifying Neogene and Quaternary geodynamic processes requires reliable age control on the geological record from which the rate and intensity of these processes are usually derived. The nature and geometry of marine sediments preserved in the southern North Sea basin, NE Belgium, are influenced by geodynamic processes such as tectonic movements and eustatic sea level changes. Yet, the geochronology of these sediments is almost entirely based on micropalaeontological analyses and subsequent correlations with widely accepted geological boundaries. In recent years, the electron spin resonance (ESR) dating method has been applied to buried sediments that range in age between $\sim$ 100 ka and several Ma. The method is based on the measurement of accumulated radiation damage in quartz crystals during burial, and can thus in theory be applied to obtain absolute numerical age control on any quartz-rich sediment given several conditions are met. The most important of these is sunlight bleaching of pre-existing radiation damage prior to burial. In this case study, we present preliminary ESR dating results of three samples from a cored borehole in Miocene glauconite-rich sands, which are biostratigraphically estimated as between 7 Ma and 11 Ma (Tortonian).

Following chemical and physical purification of the samples (taken at 107 m, 135 m and 147 m depth), quartz grains (100-200 μm) were irradiated by Co-60 gamma rays to doses between 1-150 kGy. Individual aliquots (each weighting several 100 mg) were measured at cryogenic temperatures in a JEOL X-band ESR spectrometer operating at a microwave frequency of $\sim$ 9.2 GHz. Defect densities were derived by integration of relevant ESR spectra, and making use of a comounted defect density calibrated marker sample. Subsequently, the equivalent dose was calculated using the thus constructed dose curves (including the natural, unirradiated, aliquot). Finally, dose rates were determined using high resolution gamma ray spectrometry in the laboratory.

ESR measurements allowed to identify three different species, including the AlO4, Ti-Li and E'-center. Overlapping of the AlO4 signal with other signals, and the generally poor bleaching characteristics of the E'-center led to the use of Ti-Li impurity centers for dating. Dose curves of the latter typically showed radiation saturation around doses of up to several 10 kGy, after which the ESR intensity tends to decrease quickly. Polynomial, exponential growth and linear functions were fitted to the dose curve data points, leading to equivalent dose estimates ranging between 3 kGy and 7 kGy. Given measured dose rates between 2-3 kGy/Ma, ESR ages of all three samples are younger than 4 Ma, and thus severely underestimate the biostratigraphical age of these Miocene sands. Two possible reasons for this discrepancy are being considered, involving instability of the Ti-Li signal over such long burial times, and dose rate variations during burial. Further research will concentrate on the potential use of E'-centers, and improved detection of the AlO4 signal in these samples.