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# The Neogene–Quaternary boundary at the type locality of Monte San Nicola, near Gela, Sicily – a reinvestigation by the international program GELSTRAT

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## Abstract

The Global boundary Stratotype Section and Point (GSSP) at Monte San Nicola, near Gela, Sicily, Italy was proposed in 1996 to define the base of the Gelasian Stage, then the uppermost stage of the Pliocene Series, in recognition of the intensification of Northern Hemisphere glaciation. This GSSP acquired elevated significance upon its approval in 2009 to define also the base of the Quaternary System and redefine the base of the Pleistocene Series. It is placed at the base of the marly layer immediately overlying the prominent, laminated, reddish, sapropelic Nicola bed, and has an astronomically tuned age of 2.58 Ma. The Nicola bed is assigned to Mediterranean Precession-Related Cycle 250 and aligns with an obliquity maximum representing Marine Isotope Stage 103 which, together with the Gauss–Matuyama paleomagnetic reversal, facilitates global correlation. Fine details of the stratigraphy nonetheless remain uncertain, including the precise position of the Gauss–Matuyama relative to the GSSP. GELSTRAT was inaugurated in September 2021 during an INQUA-SQS International Field Workshop focused on the reinvestigation and reanalysis of the Gelasian GSSP using modern methods and a broad range of proxies. Sampling across the boundary interval at the type section in September 2021 was supplemented by further fieldwork in April–May 2022 and resulted in the collection of 404 samples across a ~18 m stratigraphic interval spanning the GSSP and ranging from the top of bed A1 to ~10 m above the top of the Nicola bed (A5). Samples were collected at ~5 cm intervals. Pervasive fine-scale tectonic fracturing of the Monte San Nicola outcrop, coupled with the

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brittle nature of the dominant marl lithology, makes closer-interval sampling challenging although several narrow blocks of the finely laminated Nicola bed were collected for additional microstratigraphic analysis. GELSTRAT is an international collaborative program in which approaches planned or in progress include: calcareous nannofossils, foraminifers, pollen, dinoflagellate cysts, macrofossils, ichnofossils, foraminiferal stable isotopes, organic geochemistry, clay mineralogy, magnetostratigraphy, and  $^{10}\text{Be}$  analysis. The first high-resolution oxygen and carbon isotope record has been obtained in the Gelasian type section, together with detailed marine and terrestrial biotic climate signals across the boundary. The Nicola bed itself is undergoing analysis at ultrafine stratigraphic detail employing many of the above approaches but also microstratigraphy, X-ray tomography, micro-XRF elemental analysis (ITRAX), micro-RAMAN spectroscopy, Fourier transform infrared spectroscopy (FTIR), and X-ray diffraction (XRD). A refined characterization of the Gelasian GSSP will enhance its utility for the precise recognition of the base of the Quaternary on a global scale, and our integrated paleoclimate reconstructions will illuminate a crucial phase of Earth history.

**Keywords:** Quaternary, Pleistocene, Gelasian, GSSP, Monte San Nicola