15th International Congress of the Geological Society of Greece
Athens, 22-24 May, 2019 | Harokopio University of Athens, Greece
Bulletin of the Geological Society of Greece, Sp. Pub. 7 Ext. Abs. GSG2019-241

IODP Expedition 381: The potential of the new high-resolution palaeoenvironmental and palaeoclimatic record from the Corinth Gulf

K. Kouli[1], K. Panagiotopoulos[2], M. Geraga[3], M. Phillips[4], A. Cvetkoska[5], P. Diz[6], S.A. Oflaz[7], J. Everest[8], G. Carter[8], D. Shillington [9], L. McNeill[10] and Expedition 381 Scientists

(1) Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Greece, akouli@geol.uoa.gr
(2) University of Cologne, Germany
(3) Department of Geology, University of Patras, Greece
(4) University of Texas at Austin, USA
(5) Justus Liebig University, Germany
(6) Universidad de Vigo, Spain
(7) Christian-Albrechts-Universität zu Kiel, Germany
(8) ECORD Science Operator, British Geological Survey, Lyell Centre, Edinburgh, United Kingdom
(9) Lamont-Doherty Earth Observatory, Columbia University, Palisades NY, USA
(10) University of Southampton, Ocean and Earth Science, Southampton, United Kingdom

The International Ocean Discovery Program Expedition 381: Corinth Active Rift Development was conducted in late 2017 (offshore phase-drilling campaign) and early 2018 (onshore phase-Bremen Core Repository). The primary objectives of the Expedition 381 were to target the active continental Corinth Rift (Greece) in order to: a) obtain high spatial and temporal resolution records of the rifting process dynamics, b) to study the interaction of climate and tectonics on sedimentary and surface processes in a rift zone, c) to improve regional hazard assessments in one of the most seismically active regions of Europe and d) to generate a new high resolution record of Quaternary paleoclimate and paleoenvironment evolution from a semi-isolated basin dominated at present by typical Mediterranean ecosystems.

During IODP Exp. 381, three sites (Figure 1) located along the Gulf of Corinth, were drilled and logged, sampling in high resolution the syn-rift sedimentary sequence back to ~1.5 Ma or more (Shillington *et al.*, 2019; McNeill et al., 2019a). Preliminary results produced during the onshore phase of the expedition confirmed that the retrieved deposits contain a rich and complex record of the tectonics, climate and palaeoenvironment interplay in the syn-rift basin. The connection of the Gulf of Corinth to the Mediterranean is controlled by basin sills resulting in alternating aquatic conditions. These vary between open ocean/marine and isolated phases as sea level fluctuates in response to climate forcing (glacial-interglacial cycles). As a result, a unique range of paleoenvironmental gradients is encountered across the central (M0078 and M0079) and eastern (M0080) rift impacting depositional processes, sediment and water chemistry and composition of microfossil assemblages such as calcareous nannofossils, foraminifera, diatoms and dinoflagellate cysts (Shillington et al., 2019; McNeill et al., 2019a), while pollen assemblages from the same intervals record alternating periods of forest or herb vegetation in the borderlands of the Gulf of Corinth.

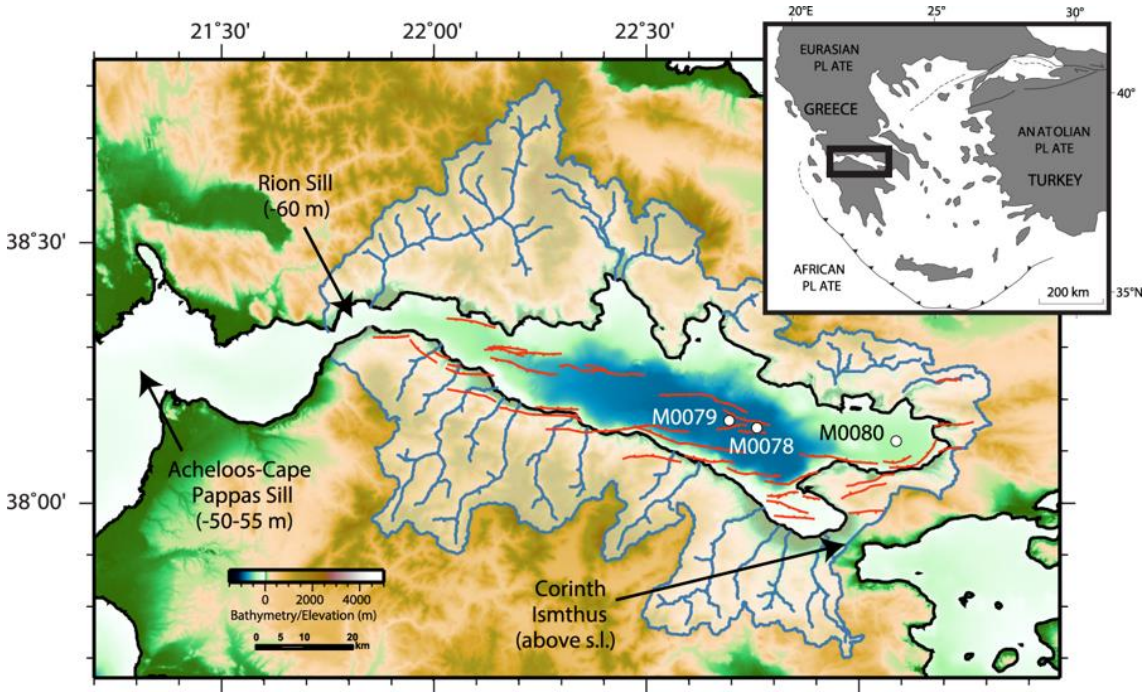

Figure 1: Map of the Gulf of Corinth and Corinth Rift system showing the locations of the three sites drilled during the IODP Expedition 381. The position of bounding sills of the Gulf, primary active faults (Nixon *et al.*, 2016) and primary catchment areas and main rivers discharging into the Gulf (Watkins *et al.*, 2018) are included. Inset: tectonic setting of Corinth rift in Aegean region, Eastern Mediterranean Sea (from Mc Neill *et al.*, 2019b).

During interglacial periods, when the sea level was high, the Gulf was connected to the global ocean and marine microfossil assemblages including foraminifera, diatoms, calcareous nannoplankton, and dinoflagellate cysts were observed. High abundances of foraminifera were recorded, while benthic foraminifer abundance was generally higher than that of planktonic foraminifers. The dominant planktonic foraminifera species (neogloboquadrinids and *T. quinqueloba*) suggest high fertility in surface waters. High abundances of buliminids and bolivinids in the benthic assemblages suggest increased organic fluxes to the seafloor. During isolated/semi-isolated periods, when the Gulf appears to have been fully or partially cut off from the global ocean complex aquatic microfossil assemblages, mainly constituted by non-marine diatoms and organic dinoflagellate cysts, suggest brackish paleoenvironmental conditions. Foraminifers tend to be absent or in low abundances, although brief intervals with higher foraminifer abundance were also observed. The transitions between the marine and isolated/semi-isolated intervals expressed in the micropaleontological and sedimentary record are particularly complex and varied in their length and character.

Preliminary pollen and terrestrial non-pollen palynomorph (NPP) assemblages analyzed during the onshore phase of the expedition allow to establish a direct link between the response of terrestrial and aquatic environments (Mc Neill et al., 2019b; Shillington et al., 2019). The Arboreal/Non Arboreal Pollen ratio (AP/NAP) fluctuates at orbital scale suggesting the alternation of forested and open landscapes in the borderlands of the Gulf of Corinth. The first palynological results point to increased AP percentages during marine intervals (interglacials), however, further analyses and a higher temporal resolution are required to understand the vegetation response at orbital and sub-orbital time scales. Quercus dominates the deciduous trees percentages, but other mesophilous trees such as Corylus, Ulmus, Carpinus, Tilia, and Acer are also encountered. Cedrus appears to be the dominant conifer tree in the older part of the sequence, while Abies in the upper. Relict pollen taxa (e.g. Carya, Pterocarya, and Liquidambar) were also encountered in the sequence. Steppic elements (e.g., Artemisia and Ephedra) are more abundant during isolated/semi-isolated intervals (glacials) and suggest the occurrence of a rather open landscape. Mediterranean sclerophyllous vegetation increases towards the top of the sequence, depicting the significant role of Mediterranean maquis in the modern vegetation surrounding the Gulf of Corinth.

Combined multiproxy results produced during the onshore phase showed the existence of significant variations in sedimentation rates in the Corinth Gulf basin between glacial and interglacial periods. These findings confirm the dominant role of Quaternary climate forcing and eustatic sea level fluctuations in shaping the paleoenvironment in the Corinth Gulf basin. Analyses of M0079 sediments revealed that during glacial periods sedimentation rates were 2 to 7 times higher than during interglacial periods (McNeill *et al.,* 2019b). Higher sedimentation rates during glacials are most likely associated with increased erosion and runoff driven by the decrease and change of vegetation cover during the glacial, also observed in other existing long Mediterranean palaeovegetation records (Sadori *et al., 2016*; Tzedakis *et al.*, 2006).

This new high-resolution palaeoenvironmental and palaeoclimatic sedimentary record can provide new insights to the the long-term vegetation dynamics in response to glacial/interglacial cycles during the last ~1Ma. Situated at a key location at the southernmost tip of the Balkan Peninsula, the Corinth Rift deposits have the potential to be an invaluable palaeo-archive that will improve our understanding concerning the the evolution of marine and terrestrial ecosystems in the Mediterranean and allow to infer lead and lag relationships between the land and sea ecosystem response.

References

McNeill, L.C., Shillington, D.J., Carter, G.D.O., and the Expedition 381 Participants, 2019a. Corinth Active Rift Development. Proceedings of the International Ocean Discovery Program, 381: College Station, TX (International Ocean Discovery Program). https://doi.org/10.14379/iodp.proc.381.101.2019

McNeill, L.C., Shillington, D.J., Carter, G.D.O., Everest, J., Gawthorpe, R., Miller, C., Phillips, M., Collier, R., Cvetkoska, A., De Gelder, G., Diz Ferreiro, P., Doan, M.-L., Ford, M., Geraga, M., Gillespie, J., Hemelsdael, R., Herrero-Bervera, E., Ismaiel, M., Janikian. L., Kouli, K., Le Ber, E., Li, S., Maffione, M., Mahoney, C., Machlusm M.L., Michas, G., Nixon, C., Oflaz, S.A., Omale, A.P., Panagiotopoulos, K., Pechlivanidou, S., Sauer, S., Seguin, J., Sergiou, S., Zhakarova, N., Green, S., 2019b. High-resolution record reveals climate-driven environmental and sedimentary changes in an active rift. Scientific Reports 9, 3116.

Nixon, C.W., McNeill, L.C., Bull, J.M., Bell, R.E., Gawthorpe, R.L., Henstock, T.J., Christodoulou, D., Ford, M., Taylor, B., Sakellariou, D., Ferentinos, G., Papatheodorou, G., Leeder, M.R., Collier, R.E.L., Goodliffe, A.M., Sachpazi, M., Kranis, H., 2016. Rapid spatiotemporal variations in rift structure during development of the Corinth Rift, central Greece. Tectonics 35, 1225-1248.

Sadori, L., Koutsodendris, A., Masi, A., Bertini, A., Combourieu-Nebout, N., Francke, A., Kouli, K., Joannin, S., Mercuri, A.M., Panagiotopoulos, K., Peyron, O., Torri, P., Wagner, B., Zanchetta, G., Donders, T.H., 2016. Pollen-based paleoenvironmental and paleoclimatic change at Lake Ohrid (SE Europe) during the past 500 ka. Biogeosciences 13, 1423–1437.

Shillington, D.J., McNeill, L.C., Carter, G.D.O., and the Expedition 381 Participants, 2019. Expedition 381 Preliminary Report: Corinth Active Rift Development. International Ocean Discovery Program. https://doi.org/10.14379/iodp.pr.381.2019

Tzedakis, P.C., Hooghiemstra, H., Pälike, H., 2006. The last 1.35 million years at Tenaghi Philippon: revised chronostratigraphy and long-term vegetation trends. Quaternary Science Reviews 25, 3416–3430.

Watkins, S.E., Whittaker, A.C., Bell, R.E., McNeill, L.C., Gawthorpe, R.L., Brooke, S.A.S., Nixon, C.W., 2018. Are landscapes buffered to high-frequency climate change? A comparison of sediment fluxes and depositional volumes in the Corinth Rift, central Greece, over the past 130 k.y.. GSA Bulletin 131 (3-4), 372–388.