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Diatom responses to precipitation and anthropogenic disturbances in an azorean lake during the last seven centuries

David Vázquez-Loureiro (1), Roberto Bao (1), Vitor Gonçalves (2), Maria J Rubio-Inglés (3), Alberto Sáez (4), Armand Hernández (5), Pedro M Raposeiro (2), Juan J Pueyo (4), Pere Masqué (6,7,8), Ricardo Trigo (5), and Santiago Giralt (3)

(1) Facultade de Ciencias, Universidade da Coruña, Campus da Zapateira s/n, E-15071 A Coruña, Spain (david.vazquez@udc.es), (2) CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Pólo dos Açores - & Departamento de Biologia da Universidade dos Açores, Rua Mãe de Deus 13 A, 9501-855 Ponta Delgada, Açores, Portugal, (3) Institute of Earth Sciences Jaume Almera CSIC, Sedimentary Geology, Lluís Solé i Sabarís s/n, E-08028 Barcelona, (4) Faculty of Geology, Universitat de Barcelona, Martí i Franquès s/n, E-08028 Barcelona, Spain, (5) Instituto Dom Luiz (IDL), Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisboa, Portugal, (6) Departament de Física, Institut de Ciència i Tecnologia Ambientals (ICTA), Universitat Autònoma de Barcelona, E-08193, Bellaterra, Spain, (7) Oceans Institute & School of Physics, The University of Western Australia, Crawley, WA 6009, Australia, (8) School of Natural Sciences & Centre for Marine Ecosystems Research, Edith Cowan University, Joondalup, WA 6027, Australia

Sedimentary lacustrine records provide an important source of knowledge of past environmental changes at regional and local scales. Here we perform a diatom-based paleoenvironmental reconstruction, complemented with geochemical proxies, of the recent history of Lake Azul (37° 52' 21" N – 25° 46' 26" W), located in the crater caldera of Sete Cidades volcano, São Miguel Island.

A 132 cm long sediment core from the offshore and deepest part of the lake was selected, from a total of fourteen cores extracted in 2011, and dated with ^{21}Pb and ^{137}Cs, as well as AMS ^{14}C. Two main litological intervals were described: at the lower part there are hard volcanic rocks interbedding silty lacustrine episodes, whereas the upper part is made up by silty mud lacustrine sediments. Eight terrestrial-nearshore levels with high values of TOC/TN ratio, low values of δ^{13}C and high abundances of aerophilic diatoms, plus nine volcanic levels, were removed from any further analysis in order to assess changes in in-lake processes. Main environmental gradients driving the composition of the diatom assemblages were explored by a Principal Component Analysis (PCA) on the diatom relative abundance data, and four statistically significant Diatom Assemblage Zones (DAZs) were defined with a cluster analysis (CONISS).

The first axis of PCA (PC1), explaining 47.3% of total variance, confronts benthic vs tychoplanktonic and euplanktonic taxa, suggesting a relationship with water depth. The second axis (PC2) explained 23.1% of total variance, showing high positive values for eutrophic taxa of the genus *Aulacoseira*, and negative values for oligotrophic taxa and diatoms of a broad trophic spectrum. This axis is very likely related to a trophic gradient.

DAZ-1 (c. 1280 – 1400 cal yr AD), dominated by benthic taxa, is characterized by positive values of PC1 and PC2, indicating relative shallow lake conditions and a high trophic level, respectively. A transition from a benthic to a facultatively planktonic community (lower PC1 values) occurs in DAZ-2 (c. 1400 – 1800 cal yr AD), suggesting a rise in water level, probably triggered by an increase in precipitation. Negative values of PC2 in this zone and DAZ-3 (c. 1800 – 1960 cal yr AD) might be explained by the dilution of nutrients in a larger water volume. The sharp transition to high positive values of PC2 in DAZ-4 (c. 1960 cal yr AD) coincides with the start in the use of nitrate- and phosphate-rich fertilizers in the surrounding farming area.

Long-term changes in diatoms assemblages since the late XIII century in Lake Azul are driven by two factors of natural and anthropogenic origin, respectively; the strong inter-annual variability of the precipitation (largely controlled by the North Atlantic Oscillation, NAO), and the eutrophication of lakes in recent decades.