

The hidden mechanistic hand: the mechanical force that drives global biogeochemical cycles

Lingyu Meng^{1,2#}, Li Xie^{2,3#}, Yong Yuan⁴, Shungui Zhou^{5*}

¹ Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, 211135, Nanjing, China.

² **University of Chinese Academy of Sciences, 211135 Nanjing, China.**

³ State Key Laboratory of Lake and Watershed Science for Water Security, Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, 211135, Nanjing, China.

⁴ School of Environmental Science and Engineering, Institute of Environmental Health and Pollution Control, Guangdong University of Technology, 510006, Guangzhou, China

⁵ Fujian Provincial Key Laboratory of Soil Environmental Health and Regulation, College of Resources and Environment, Fujian Agriculture and Forestry University, 350002, Fuzhou, China.

[#]Co-first authors are acknowledged with a [#] symbol.

* Corresponding author, E-mail: sgzhou@fafu.edu.cn

The manuscript is submitted to *Environmental and Biogeochemical Processes*

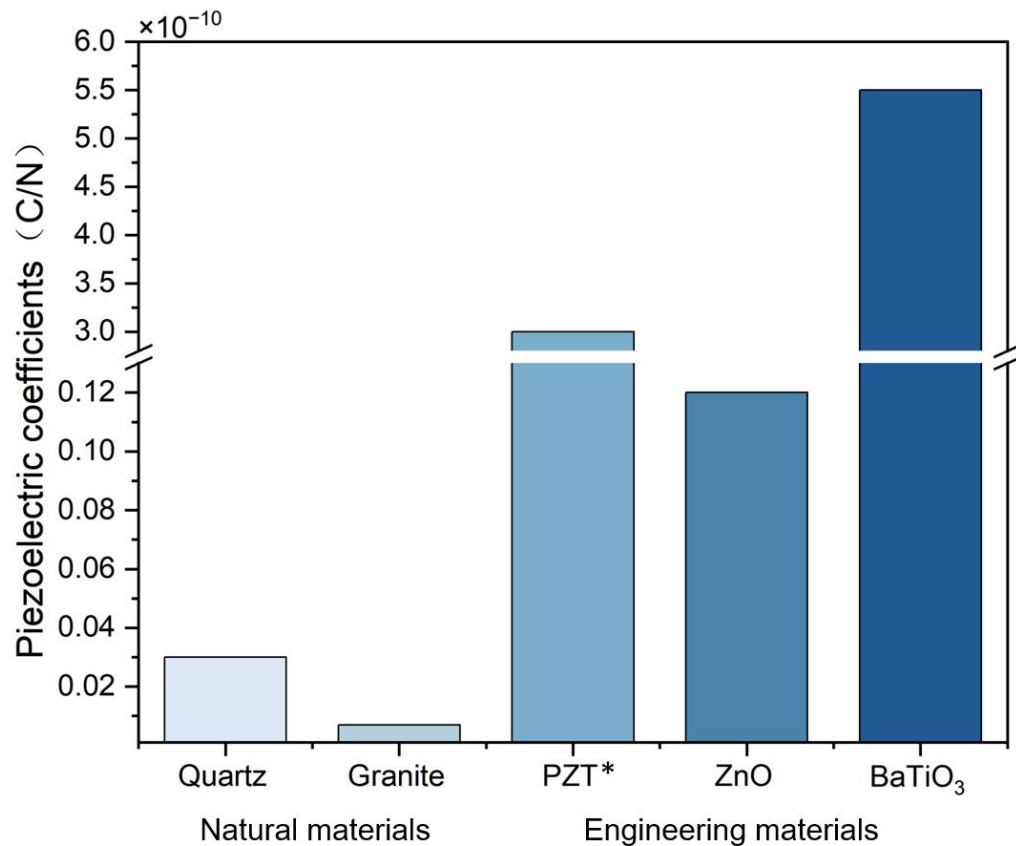


Figure S1. Piezoelectric coefficients of various piezoelectric materials. PZT*: Lead zirconate titanate. Data on piezoelectric coefficients were obtained from the following references^[1–3].

Reference

- [1] N. Bhadwal, R. Ben Mrad, K. Behdinin, Review of zinc oxide piezoelectric nanogenerators: piezoelectric properties, composite structures and power output, *Sens. (Basel Switz.)* 23 (2023) 3859. <https://doi.org/10.3390/s23083859>.
- [2] Electricity - charge, current, voltage | britannica, (2025). <https://www.britannica.com/science/electricity/Electric-properties-of-matter> (accessed October 13, 2025).
- [3] M. Wu, R. Yao, C. Jin, Y. Xu, J. Xu, L. He, Y. Yang, Y. Liu, L. Zhong, J. Gao, Significantly enhanced piezoelectric properties of BaTiO₃-based ceramics with unchanged curie temperature via local chemical inhomogeneity, *Chem. Eng. J.* 518 (2025) 164844. <https://doi.org/10.1016/j.cej.2025.164844>.