Stanford

Alireza Namayandeh

Postdoctoral Scholar, Earth System Science

Bio

BIO

Alireza Namayandeh is an NSF Earth Science Postdoctoral Fellow at the Doerr School of Sustainability at Stanford University. He is interested in understanding the formation, transformation, and environmental impacts of metal-bearing nanoparticles in soil, water, and air, particularly their role in transporting toxic metals and influencing human and ecosystem health. His current research focuses on how biomass burning during wildfires generates toxic metal nanoparticles and affects their chemical and physical properties in soil and air.

Prior to joining Stanford, he conducted research in geochemistry, mineralogy, and nanoscience at Virginia Tech, where he earned his Ph.D. in Environmental Geochemistry. His doctoral work examined the formation and transformation of iron oxy-hydroxide nanoparticles and their interactions with environmental contaminants such as arsenic, phosphate, and nitrate. A key focus of his research was the identification and characterization of ultrasmall (~1 nm) precursor clusters that serve as building blocks for metal nanoparticles like ferrihydrite. His work provided the first direct structural evidence for the formation of these clusters, revealing their role in contaminant transport and metal mobility in natural environments. By integrating synchrotron X-ray techniques, electron microscopy, and in situ laboratory experiments, he demonstrated how these clusters remain suspended in water and air, enhancing the long-range dispersion of toxic metals.

More recently, his research has expanded to investigate the role of wildfires in mobilizing toxic metal nanoparticles, particularly through airborne particulate matter. His studies have shown that wildfire smoke contains a significant fraction of ultrafine metal-bearing nanoparticles that can be transported over long distances and pose severe health risks. By analyzing wildfire smoke samples from major fires across the Western U.S. and conducting controlled burning experiments, he is working to quantify the mechanisms by which toxic metal nanoparticles are generated, transported, and deposited into ecosystems. As part of this work, he is leading efforts to assess toxic metal nanoparticles in smoke, ash, and debris from the Eaton and Palisade wildfires in Los Angeles, studying their potential for airborne transport and human exposure. His goal is to apply these findings to inform wildfire mitigation strategies and public health policies, addressing the increasing risks posed by climate-driven wildfires in the US.

HONORS AND AWARDS

- NSF Earth Science Postdoctoral Fellow, National Science Foundation (NSF) (2024-2026)
- PRISM Baker Fellowship, Stanford University (2022-2023)
- Interdisciplinary Graduate Education Fellowship, Virginia Tech (2021-2022)
- Interdisciplinary Graduate Education Fellowship, Virginia Tech (2018-2019)

STANFORD ADVISORS

- Scott Fendorf, Postdoctoral Faculty Sponsor

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Alireza Namayandeh's research focuses on the formation, transformation, and environmental impacts of metal-bearing nanoparticles in soil, water, and air, with a particular emphasis on their role in wildfire-generated pollution. His work investigates how wildfires contribute to the release and transport of toxic metal nanoparticles, assessing their chemical and physical properties and their implications for human health and ecosystem contamination.

His current research, supported by the NSF Earth Science Postdoctoral Fellowship, explores the mechanisms by which biomass burning generates toxic airborne nanoparticles and how soil mineralogy influences their formation. By combining laboratory experiments, synchrotron-based spectroscopy, electron microscopy, and field studies, he aims to better understand the pathways of metal mobilization during wildfires. He is also leading efforts to analyze ash and soil samples from recent wildfires in California, including the Eaton and Palisade fires in Los Angeles, to assess the risks associated with airborne metal nanoparticles.

Beyond wildfire-driven pollution, he is interested in the fundamental geochemistry of nanoparticle formation and transport. His previous work on precursor clusters of iron oxy-hydroxides provided new insights into the formation of metal-bearing nanoparticles and their role in controlling contaminant mobility in the environment. He continues to explore how ultrafine particles interact with toxic metals, organic matter, and microbial communities in both terrestrial and atmospheric systems.

His broader scholarly interests include wildfire geochemistry, atmospheric particulate matter, environmental mineralogy, and the intersection of environmental geochemistry and public health. His goal is to develop a deeper understanding of how natural and anthropogenic processes influence the formation and dispersion of hazardous nanoparticles, ultimately contributing to improved air quality standards, risk assessment models, and environmental policies in wildfire-prone regions.

LAB AFFILIATIONS

- Scott Fendorf, Soil and Environmental Biogeochemistry (10/12/2022)

Publications

PUBLICATIONS

- **Nonlinear Redox Transformations of Chromium in Soil during Wildfire Heating: The Critical Role of Iron Mineralogy.** *Environmental science & technology*
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- **Temporal decoupling of metal(loid) binding and microbial adaptation in arsenic and cadmium contaminated soils under changing climates.** *Journal of hazardous materials*
  Wang, T., Roschke, C., Sánchez, N., Duncan, A. H., Namayandeh, A., Fendorf, S., da Rocha, U. N., Muehe, E. M.
  2025; 501: 140787
- **Formation and transformation of iron oxy-hydroxide precursor clusters to ferrihydrite** *ENVIRONMENTAL SCIENCE-NANO*
  Namayandeh, A., Borkiewicz, O. J., Sassi, M., Rosso, K. M., Michel, F.
  2024; 11 (9): 3966-3978

- **Goethite and Hematite Nucleation and Growth from Ferrihydrite: Effects of Oxyanion Surface Complexes.** *Environmental science & technology*
  Namayandeh, A., Zhang, W., Watson, S. K., Borkiewicz, O. J., Bompoti, N. M., Chrysochoou, M., Penn, R. L., Michel, F. M.
  2024
- **Effects of Oxyanion Surface Loading on the Rate and Pathway of Ferrihydrite Transformation** *ACS EARTH AND SPACE CHEMISTRY*
  Namayandeh, A., Borkiewicz, O. J., Bompoti, N. M., Watson, S. K., Kubicki, J. D., Chrysochoou, M., Michel, F.
  2023
- **Oxyanion Surface Complexes Control the Kinetics and Pathway of Ferrihydrite Transformation to Goethite and Hematite.** *Environmental science & technology*
  Namayandeh, A., Borkiewicz, O. J., Bompoti, N. M., Chrysochoou, M., Michel, F. M.
  2022
- **TRACE AND RARE EARTH ELEMENT DISTRIBUTION AND MOBILITY DURING DIAGENETIC ALTERATION OF VOLCANIC ASH TO BENTONITE IN EASTERN IRANIAN BENTONITE DEPOSITS** *CLAYS AND CLAY MINERALS*
  Namayandeh, A., Modabberi, S., Lopez-Galindo, A.
  2020; 68 (1): 50-66
- **Calorimetric study of the influence of aluminum substitution in ferrihydrite on sulfate adsorption and reversibility** *JOURNAL OF COLLOID AND INTERFACE SCIENCE*
  Namayandeh, A., Kabengi, N.
  2019; 540: 20-29
- **Genesis of the Eastern Iranian bentonite deposits** *APPLIED CLAY SCIENCE*
  Modabberi, S., Namayandeh, A., Setti, M., Lopez-Galindo, A.
  2019; 168: 56-67
- **Characterization of Iranian bentonites to be used as pharmaceutical materials** *APPLIED CLAY SCIENCE*
  Modabberi, S., Namayandeh, A., Lopez-Galindo, A., Viseras, C., Setti, M., Ranjbaran, M.
  2015; 116: 193-201