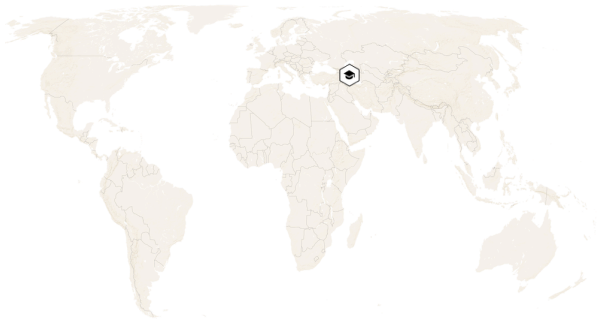
MEASURING MUD VOLCANO METHANE EMISSIONS IN AZERBAIJAN

The first comprehensive study using airborne measurements to quantify and characterize methane emissions from mud volcanoes in Azerbaijan.



DONOR:
Oil and Gas Climate Initiative (OGCI)

BENEFITTING COUNTRIES OR REGIONS:
Azerbaijan

SECTOR:
Other

STATUS:
Ongoing

TIMELINE:
Scientific article published by the end of 2026

IMEO SCIENCE OBJECTIVE:

- **Validate measurement-based approaches.**
- **Characterize regions, sectors, and emission sources where significant discrepancies exist among current emissions estimates.**



Pictures (provided by PI) Alina Fiehn / Manuel Moser

KEY FINDINGS

The methods used in this study (drone-based acquisition and Gaussian plume modelling) were for the first time employed in the case of mud volcanoes. The calibration was completed using controlled release experiments at real sites in Azerbaijan. The interpretation of the data to derive flux estimates shows the feasibility of the method in the case of mud volcanoes and the model parametrization can serve as reference for future work using this methodology.

This study has determined the magnitude of methane emissions from some of the most active mud volcanoes on Earth, some of which have never been measured before. Gas composition results enabled the distinction of mud volcano emissions from nearby oil and gas exploitations and validated or discarded the mud volcano quantifications.

RATIONALE

To reduce uncertainties in the global methane budget, it is crucial to provide a more accurate quantification of natural emissions. Natural emissions include wetlands, freshwaters, wild animals, termites, gas hydrates and geological formations such as mud volcanoes. With nearly 400 active sites, Azerbaijan hosts the highest density of mud volcanoes on Earth. The study aims to quantify methane emissions from mud volcanoes using atmospheric measurements. The campaign will also characterize mud volcano-emitted gas. Since methane from mud volcanoes and exploited oil and gas reservoirs have a similar chemical fingerprint, the study will help better apportion global total methane emissions into natural sources such as mud volcanoes versus anthropogenic sources such as oil and gas.

RELATED PUBLICATIONS

In progress

CATALYZING ACTION

The German Aerospace Center (DLR) works with collaboration and support from drone-operating company Olimp. A team of unmanned aerial vehicle pilots has been trained to perform survey flights with remote support. This local service provider can subsequently apply the methodology to other emission sources in the country.

SIGNIFICANCE FOR DECISIONMAKERS

Uncertainties in the global methane budget remain, slowing down mitigation strategies. The gap between emissions derived from inventory and atmospheric measurements is the largest for natural sources. More measurements help bridge this gap and improve our global understanding of methane emissions. This study focuses on the contribution from mud volcano eruptions in Azerbaijan, which is also a major oil and gas producer. The distinction between anthropogenic and natural sources of methane from below Earth's surface, showcased in this study, will be required to guide mitigation strategies. Measurement methods and local partnerships developed through this campaign will pave the way for future missions in a region where measurement data is generally lacking.

OTHER SUPPORTERS/STAKEHOLDERS

Principal Investigator:
German Aerospace Center (DLR), Germany

STUDY APPROACH/ACTIVITIES

A methane-measuring instrument aboard a fixed-wing drone collected methane concentration data around individual mud volcanoes. The flight patterns follow circles at different altitudes and at a fixed radius around the volcano crater. Data analysis consisted of a mass-balance approach to convert methane enhancements downwind of the crater to an emission flux. Azerbaijan has a dense cluster of mud volcanoes that emit methane daily, independently from eruption events, which allows for repetitive visits at several sites to see how emissions rates vary. Samples were taken from the surface, close to visible emission sources, both natural (e.g., gas bubbling, fumes) and anthropogenic (e.g., oil and gas extraction or processing facilities). Samples were analyzed in the laboratory for gas composition and stable isotopic ratios.



Pictures (provided by PI), Alina Fiehn / Manuel Moser

The UN Environment Programme's International Methane Emissions Observatory (IMEO) exists to provide open, reliable, and actionable data to the individuals with the agency to reduce methane emissions. IMEO does this by integrating and reconciling data across sources, including its global methane science studies. IMEO supports measurement and research studies around the world to close the knowledge gap on methane emissions and provide policy-relevant insights to decisionmakers.