



Event Response

Area of Interest: Fentale Volcano, Ethiopia
Date Covered: 05 December 2024 - 10 January 2025
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Data Used:

- InSAR images collected by the European Sentinel-1 satellite and processed using the COMET LIC SAR system (<https://comet.nerc.ac.uk/comet-lics-portal/>)
- InSAR images acquired by the COSMO-SkyMed (CSK) satellite, provided through the CEOS GVEWERS programme and processed at the University of Bristol using GAMMA.
- USGS Earthquake Catalogue (<https://earthquake.usgs.gov/earthquakes/search/>)

Recent Activity:

Unrest is continuing, with the latest 12-day Sentinel-1 descending interferogram showing further northeast-wards propagation of the dike (~8 km longer), where deformation reached Dofen (Fig 1). Maximum line-of-sight (LOS) surface displacement associated with dike opening is larger than 1 m. Subsidence at Fentale has also increased, from ~28 cm of LOS displacement away from the satellite from 17-29 December to ~45 cm of LOS displacement from 29 December – 10 January. Deformation visible to the north of Dofen are likely associated with surface faulting due to the > M5 earthquakes. In the period of 29 December to 10 January, the USGS reported 86 M4.1-5.7 earthquakes.

The dense acquisitions of CSK data enable monitoring of the dyke propagation. Fig.2 presents wrapped interferograms from CSK (ascending and descending tracks) and Sentinel-1 data, spanning the period from 5th December to 10th January. The start date precedes the onset of the event, and the wrapped interferograms are plotted in chronological order to show the progression of the dyke intrusion. Figure 3 illustrates the progression of the dyke and clearly show the effect segmentation and change in orientation have on the rate of tip propagation.

- Deformation began sometime between 17th and 21st December (Fig 2a,b).
- Initially, deformation was localised within 25 km of Fentale, with deformation up to approximately 15.6 cm in the LOS direction (Fig 2b-f). During this time, the dyke tip propagated about 7 km in 3 days at a bearing of ~040 degrees.
- Between 24th and 29th December, there was a change in direction, accompanied by an acceleration in dyke propagation. The dyke tip propagated about 24 km in 5 days (Fig 2f,g) and reached the neighbouring volcano Dofen, 47 km to the north of Fentale. The direction of the dyke changes from radial to Fentale to aligned

with the rift axis ($\sim 020^\circ$). LOS deformation associated with dyke opening is ~ 36 cm.

- After 29th December, the dyke continued to propagate but at a slower rate of about 15 km in 12 days (Fig 2j-m). The total los deformation reached >1 m by 10th January (Fig 2m), which corresponds to significant dyke opening without lengthening.
- The ascending track of the CSK data (Fig 2c,i) shows continuous subsidence at Fentale, with local LOS displacement reaching up to 36 cm on 31st December.

Forward Look:

As of 13 January, seismicity is ongoing. We will continue to monitor surface deformation with the upcoming Sentinel-1 and COSMO-SkyMed images. This, in combination with other data, observations and models, will provide evidence on which the potential evolution of the event can be considered. A scientific committee comprising scientists from Addis Ababa University (IGSSA and School of Earth Science), the Geological Institute of Ethiopia and other relevant institutions is monitoring the events and keeping the Ethiopian Disaster Risk Management Commission (EDRMC) and the public continuously informed. The government has reminded citizens to follow precautionary messages given by professionals.

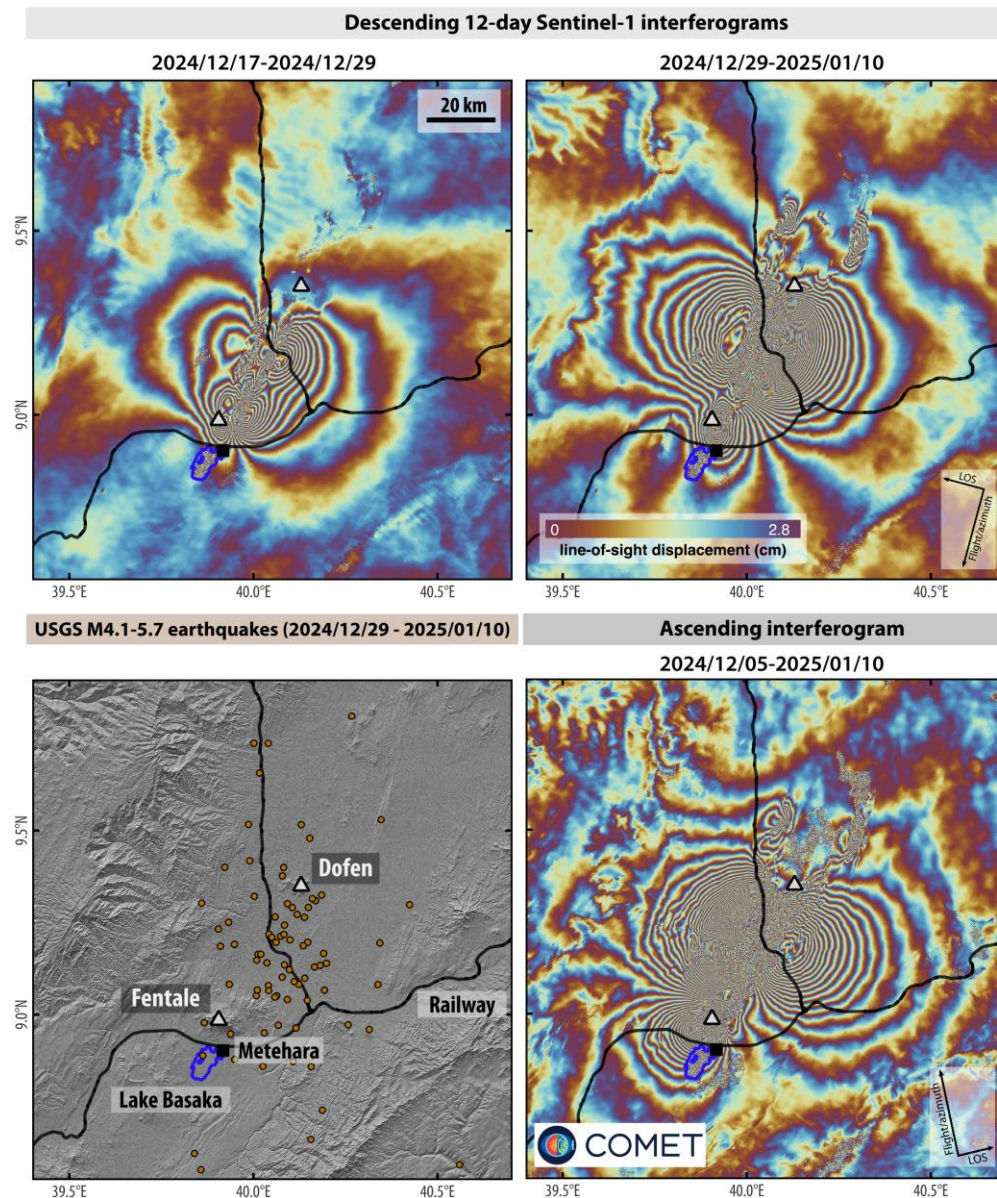


Fig 1. Sentinel-1 ascending and descending interferograms, with the latest image showing further propagation of the dike to the northeast, reaching Dofen. There is evidence of surface faulting north of Dofen from the latest interferograms. The locations of earthquakes reported by USGS from 29 December 2024 to 10 January 2025 are also shown.

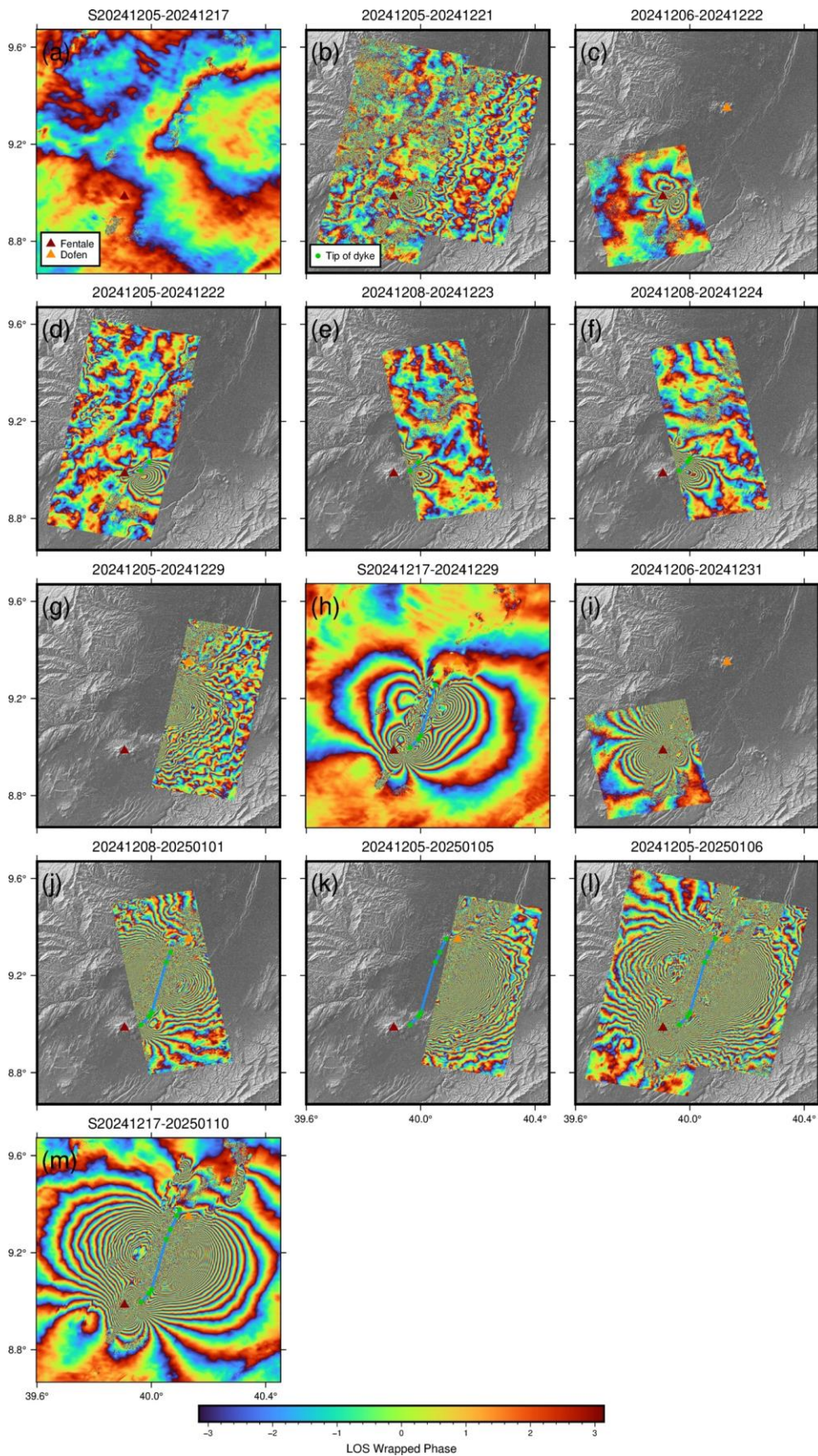


Fig 2. Wrapped interferograms from CSK and Sentinel-1. Interferograms derived from Sentinel-1 are labeled with a 'S' to indicate that the fringe wrap corresponds to ~2.8 cm of LOS displacement, while others from CSK corresponds to ~1.6 cm per fringe wrap.

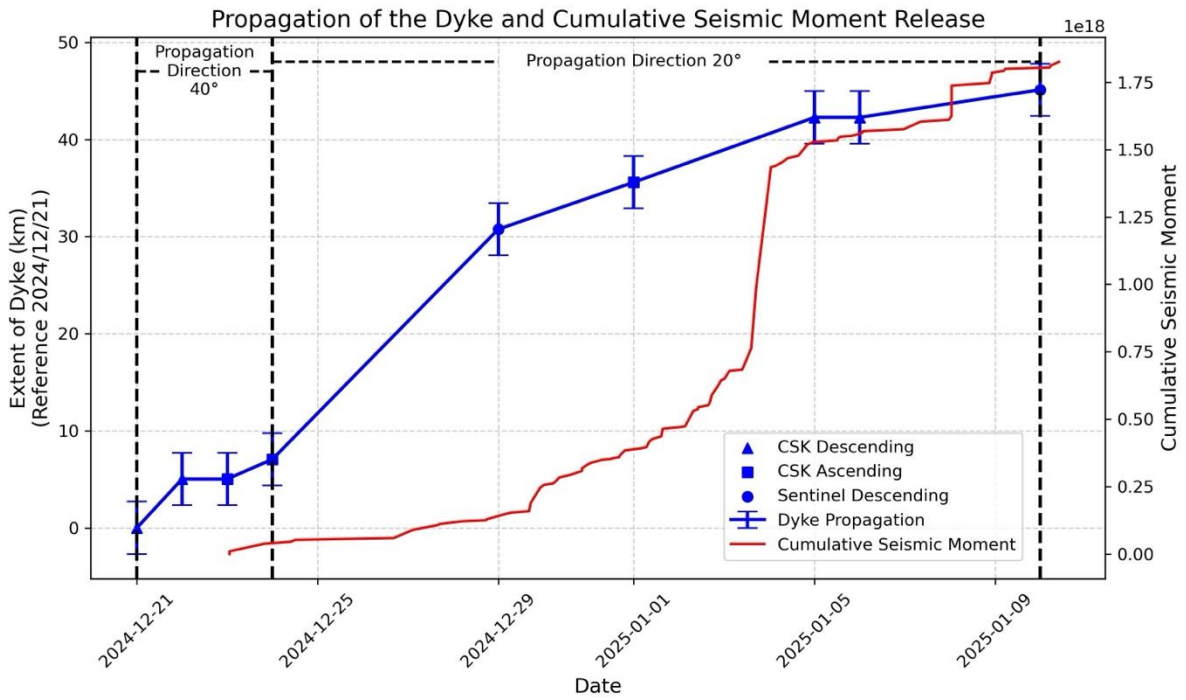


Fig 3. Dyke propagation and the cumulative seismic moment release over time. Different markers represent different satellite geometries. Error-bars estimated using the difference in tip locations between interferograms with same end date from CSK ascending and descending tracks.