German Aerospace Center

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TerraSAR-X image of the month: Ground uplift under Staufen's Old Town

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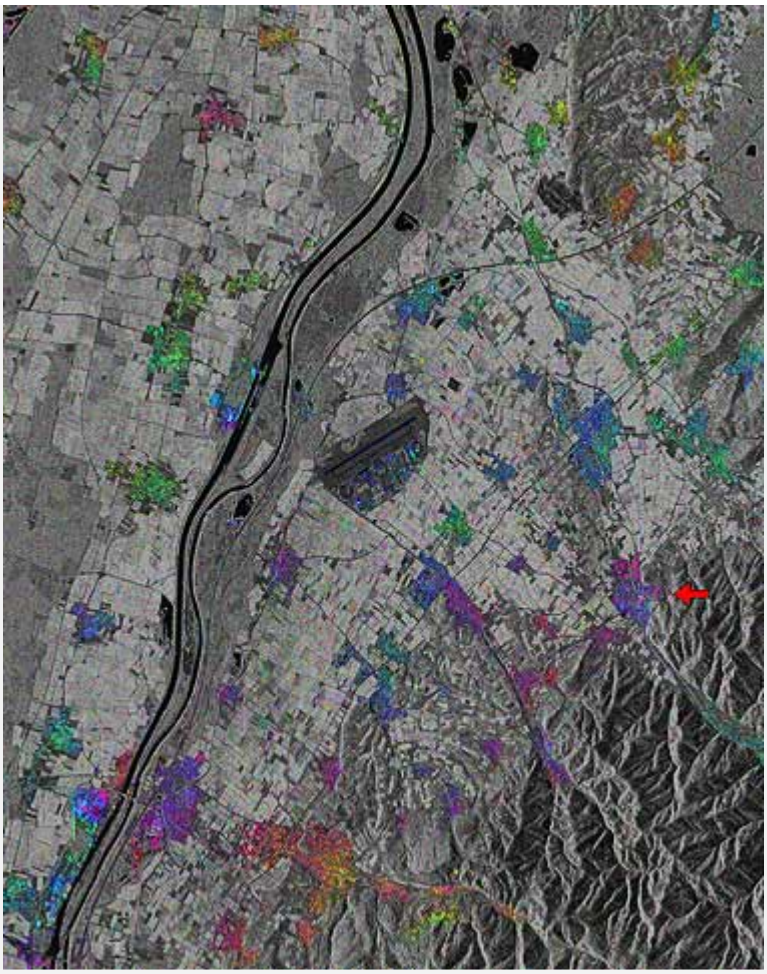
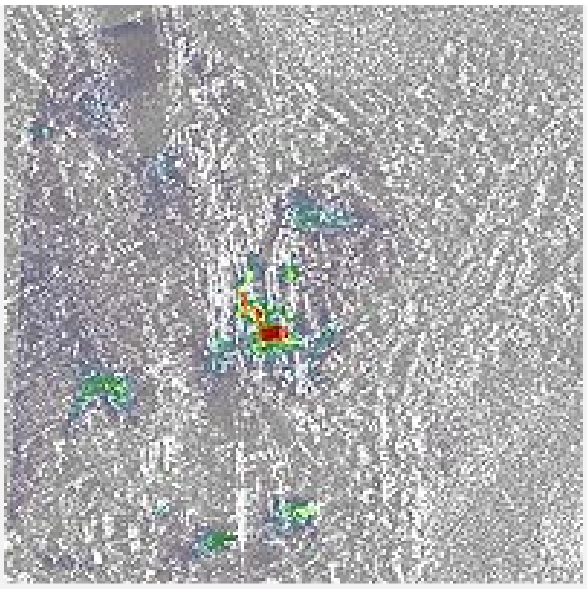


Part of the southern Rhine Rift Valley near Freiburg

The image, acquired by the German radar satellite TerraSAR-X, shows part of the southern Rhine Rift Valley near Freiburg and the city of Staufen (red arrow). To create this image, two separate images that were acquired by the satellite six months apart during 2008 were combined to form what is known as an interferogram. (For an explanation, see the caption for the main figure.) In the built-up area of Staufen, a clear pattern of deformation can be seen. For an initial evaluation of this pattern, two such interferograms were combined; the result is an elevation of the substrata by approximately three centimetres that occurred between January and October 2008.



The built-up area of Staufen

Since September 2007, numerous buildings in Staufen's Old Town have begun to exhibit large cracks that have formed due to the uplift of the substrata. The extent of the damage is considerable and there is no end to the uplift process in sight. A geochemical process called anhydrite swelling has been confirmed as the cause of these uplifts. This is a transformation of the mineral anhydrite (anhydrous calcium sulphate) into gypsum (hydrous calcium sulphate). A pre-condition for this transformation is that the anhydrite is in contact with water, which is then stored in its crystalline structure. This absorption of water causes the anhydrite to increase in volume by around 60 per cent, leading to the observed uplifts and the associated damage to the buildings in Staufen.

Possible causes of the elevation

What caused the anhydrite and water to come into contact beneath Staufen has not yet been fully determined and is the subject of ongoing geological studies. One possible cause could be groundwater permeating the anhydrite deposit due to tectonic shifts. Another cause could be the geothermal energy drilling that was carried out in the late summer of 2007, which may have destroyed a natural barrier layer between the groundwater and the anhydrite deposit, making contact between them possible. TerraSAR-X project scientists and industry are currently carrying out detailed studies on the cause, progression and effects of the anhydrite swelling.

The TerraSAR-X mission

TerraSAR-X is the first German satellite that has been manufactured under what is known as a Public-Private Partnership (PPP) between the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and Astrium GmbH in Friedrichshafen. The satellite travels around Earth in a polar orbit and records unique, high-quality X-band radar data about the entire planet using its active antenna. TerraSAR-X works regardless of weather conditions, cloud cover or the absence of daylight and is able to provide radar data with a resolution of down to one metre.

DLR is responsible for using TerraSAR-X data for scientific purposes. It is also responsible for planning and implementing the mission as well as controlling the satellite. Astrium built the satellite and shares the costs of developing and using it. Infoterra GmbH, a subsidiary company founded specifically for this purpose by Astrium, is responsible for marketing the data commercially.

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