Recognizing Structures Associated with Extensional Detachment Faults using GIS Techniques and Remotely Sensed Data from Greece

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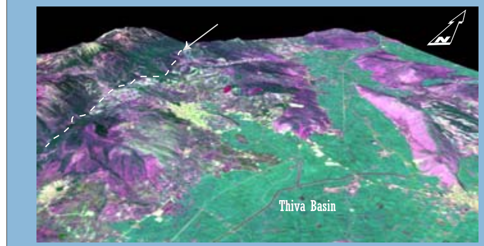


Fig. 1. The results of the satellite image spectral analysis show the contrast between the alpine basement (purple) and the recent deposits covering the Thiva basin. In this interpretation the structures on the hanging wall of the Beotikos-Kifissos detachment fault are very well extracted.

Fig. 2. Steeper fault surfaces on the hanging wall of the Beotikos-Kifissos detachment fault are very well identified at this pseudo chromatic, three dimensional representation. The detachment is at the far upper right corner, beyond Thiva basin. The yellow areas represent Neogene deposits that lie unconformably over the alpine basement which in this interpretation is colored green.

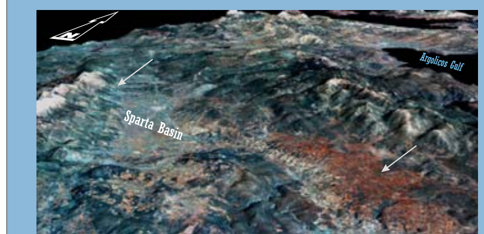


Fig. 3. The Sparta basin is located at the foot wall of the Eastern Peloponnesus detachment. It's western boundaries are controlled by another active fault zone. The nearly natural color image in this interpretation show the post-alpine sediments (brown) of Neogene age, lying unconformably over the alpine basement (green). The contemporary basin (cyan) has migrated more to the west, toward the active structures.

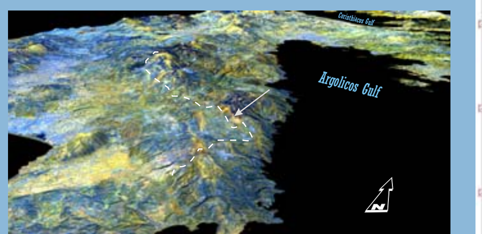


Fig. 4. Perspective view of the East Peloponnesus detachment fault and its gently dipping surfaces towards the Argolicos Gulf. After the spectral analysis and interpretation the dark blue and yellow colors represent the rock formations of the hanging wall in contrast to the green and light blue colors that represent rock formations of the foot wall of the detachment.

ABSTRACT

A number of extensional detachment faults have been recognized in the broader Aegean area. Continuing work in onshore Central Greece reveals a broad system of such faults of Mio-Pliocene age that have been largely unrecognized by previous studies.

As a reconnaissance tool, we are experimenting with techniques for interpreting satellite images and high resolution digital elevation data to identify topographic features that are commonly associated with low angle normal faults.

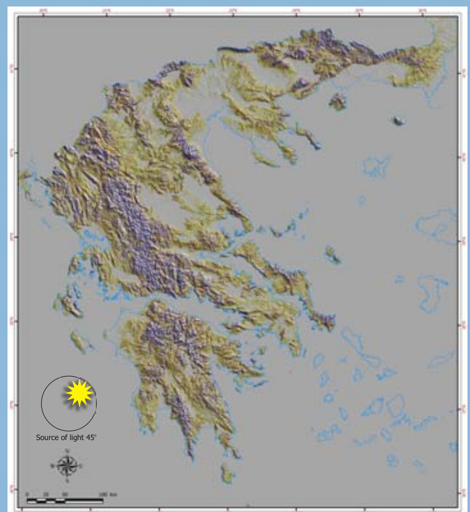
Data analysis includes running specific imaging algorithms in a GIS environment, processing of digital satellite images, and extraction of slope and shaded relief maps. Processing of satellite images includes spectral analysis in addition to spatial enhancement, focusing on differentiating the basement rocks from the relatively younger sediments and identifying the recently formed basins, especially their boundaries.

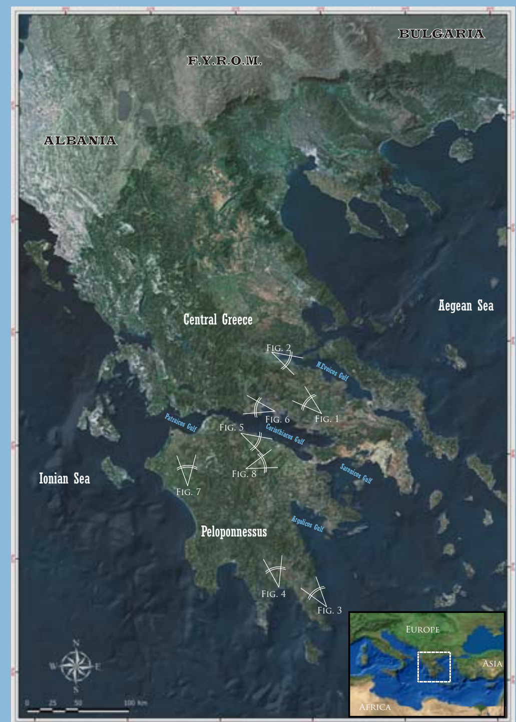
In this presentation we show results of this imaging process for some of the faults already identified through field work as extensional detachments in central and southern Greece.

On the final GIS images, the Beotikos-Kifissos detachment fault can be observed as a smooth, gently dipping surface that bounds the southwestern margin of the Late Miocene to Pliocene Thiva basin. Likewise, the East Peloponnesus detachment fault is recognizable on the images, reaching from the southeastern end of the Peloponnesus northward to the Gulf of Corinth.

Gently dipping surfaces that appear similar to these are visualized within a broad zone reaching eastward from the Gulf of Corinth to the Aegean Sea. These gently-dipping surfaces (and associated tectonic structures) form a morphologic pattern that is distinctly different from that of western Greece, suggesting that the region east of the Corinth Gulf has been pervasively deformed by a broad system of gently-dipping normal faults of probable Mio-Pliocene age.

Field mapping planned for the future will be necessary to ground-truth the nature and age of these apparent low-angle surfaces.





High resolution digital elevation models (25 meters) were used to create shaded relief and slope maps because one of the first stages in studying a large area is understanding the topography and correlating it with the known structures. The ability to change the illumination direction using GIS software aids in the determination of the areas that could be of interest for field observation. Combining the shaded relief with binned slopes gives us another useful tool for examining the response of earth's surface to tectonic processes. The slope bins that were more useful in this work were 4°-12° (yellow), 12°-20° (orange) and 20°-30° (blue). The discontinuity of those bins more or less delineate on the margins of basins related to structures accommodating ongoing or past extension.

The next step involves satellite image interpretation, mostly using Landsat 7 ETM+ images. Merging the panchromatic band and the multi-spectral data increases the spatial resolution. Ortho-rectifying the resultant images gives the opportunity to use the images in three dimensions. The use of remote sensing images in three dimensions also requires high resolution digital elevation models. The interactivity of such techniques proves to be a very powerful tool for observing an area from a distance and helps in choosing the most interesting places for fieldwork.

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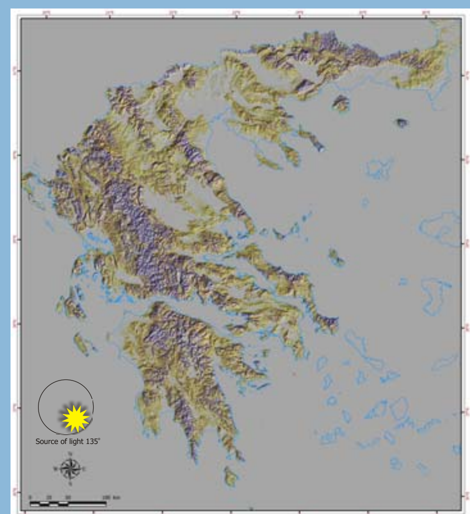


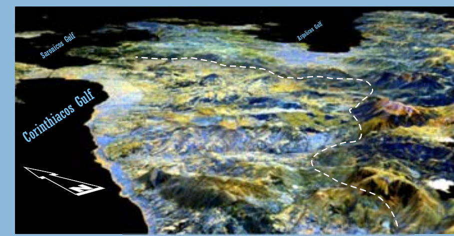
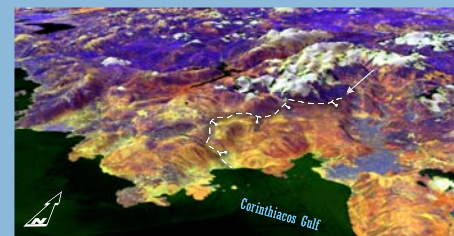


Fig. 5. The combination of image interpretation and topography exaggeration lead to identification of a potential detachment surface along the northern coast of Peloponnesus. Marine terraces (yellow) and alluvial fans (cyan) cover unconformably the alpine basement at the hanging wall (left). The darker colors of the foot wall (right) represent the relatively uplifted, basement rocks.



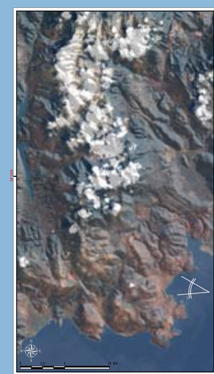


Fig. 6. The probable continuity of the East Peloponnesus detachment of the north coast of the Corinthiacos Gulf. In this interpretation the foot wall rock formations (purple) are very well differentiated from the hanging wall's (orange), especially in the northern part of its exposure.

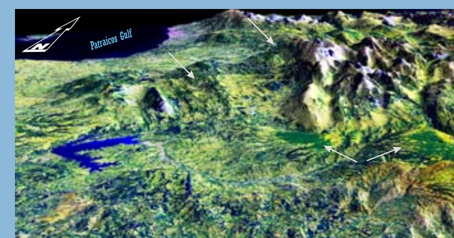
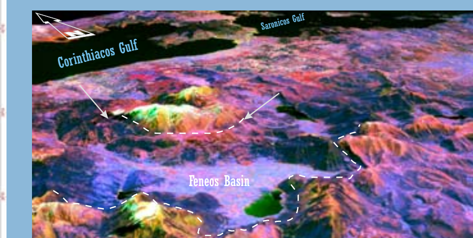


Fig. 7. The vertical exaggeration applied in this interpretation shows a high morphological contrast between the two mountainous areas northeast of the artificial lake. In this relatively flat area covered by Neogene age, sediments, possible tilted blocks are uplifted and rotated to the east where a fault zone is located. This structure is bounded by another, of almost perpendicular fault covered by alluvial fans (green).



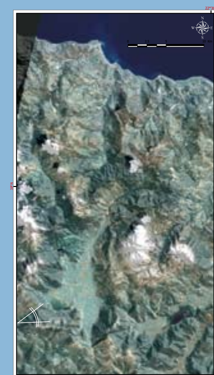


Fig. 8. In this three dimensional representation of the Feneos basin area, the detachment fault surface is very clear as the color contrast that is associated with different tectono-stratigraphic units is also associated with the morphology.