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PHOTOGEOLOGICAL INTERPRETATION OF SATELLITE IMAGES

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Abstract. Most of the geological information comes from detailed field investigation by geologists. In addition some of us use airborne and satellite remote sensing technology to supplement their in situ investigations. The remotely sensed images are routinely interpreted to identify lithology, structure, drainage-pattern characteristics, and landforms.

ASTER (The Advanced Spaceborne Thermal Emission and Reflectance Radiometer) is a research facility instrument. It is sensor systems with a unique combination of wide spectral coverage and high spatial resolution. The ASTER instrument has three spectral bands in the visible and near-infrared (VNIR), six bands in the short-wave-infrared (SWIR), and five bands in the thermal infrared (TIR) regions respectively. The ASTER also has a back-looking VNIR telescope, thus, stereoscopic images are acquired at 15-m resolution. The main aim of this article is to illustrate the ASTER's ability to provide information for lithology and geological structures and comparing the out coming data to those of the existing geological and structural maps.

Introduction

Remote sensing methods include aerial and satellite observations of the surfaces and the atmospheres of the Earth and the other planets in our solar system also. Usage of the satellite imagery has many benefits than other sources of geographic data as the aerial photography and the paper maps. For large areas satellite images are often less expensive than other sources of information. The focus of this article concerns photogeological interpretation of the ASTER images for the Earth's structures investigations.

The aim of present study is to correlate the received information about the geological structures in the investigated area from the ASTER images with that observed in the field and described at the existing geological and structural maps and publications. The ASTER data have been processed, the stereo images have been obtained. GIS (ArcGis 8.2) software have been used to determinate the structural element in the investigated area, whereas PCI Geomatica 9.1 software have been used to obtain the stereo images for the Panagyurishte ore region.

ASTER overview

The Advanced Spaceborne Thermal Emission and Reflectance Radiometer (ASTER) is a research facility instrument, launched on NASA's Terra spacecraft in December 1999. The ASTER has 14 spectral bands in the visible and near-infrared (VNIR), the short-wave-infrared (SWIR), and in the thermal infrared (TIR) regions (ASTER Ref. Guide, 2003).

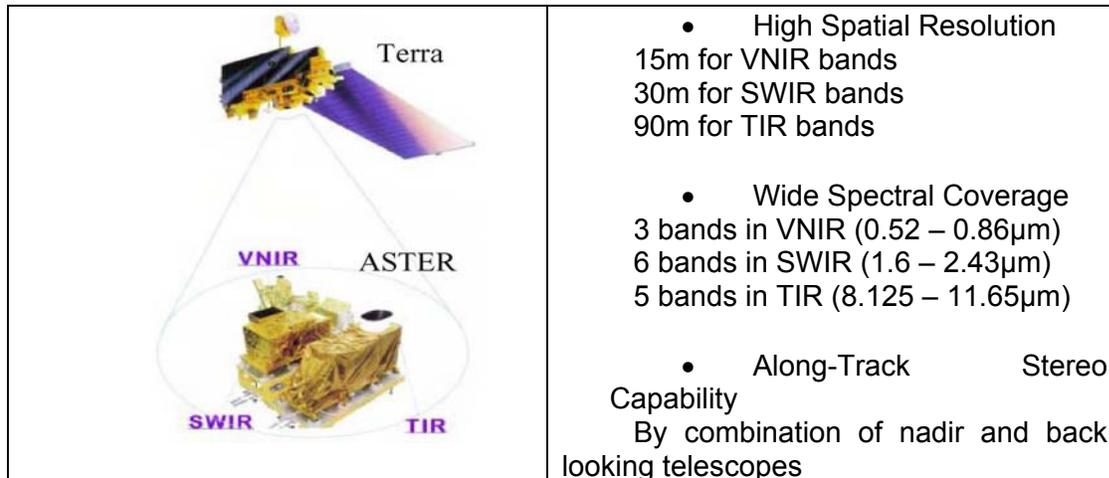


Fig. 1. Main characteristics of the ASTER instrument (ASTER Ref. Guide, 2003).

The ASTER data is expected to contribute to a many scientific areas as the geology, natural hazard monitoring, soils studies, vegetation and ecosystem dynamics, hydrology, land surface climatology, land surface and land cover change, volcano monitoring, aerosols and clouds. The ASTER false-color and band-ratio images are very useful for the geological mapping, especially for the identification of the rock and hydrothermal alteration types (Yamaguchi et al., 1998, 2001).

The ASTER **VNIR** data has 15 m resolution, which is one of the best resolutions for multispectral data commercially available from the satellites. The VNIR can be especially useful for topographic interpretations, because of its along-track stereo coverage, as well as in assessing of the vegetation and iron-oxide minerals in surface soils and rocks.

The **SWIR** data consist of 6 bands, designated as 4 to 9. The spectral bandpasses of the SWIR bands were selected for the purpose of surface mineralogical mapping. The band 4 is conformable to the spectral range where most rocks and minerals have maximum reflectivity. The bands 5 to 9 cover the Shortwave Infrared ranges where many OH⁻ bearing and carbonate minerals have absorption features.

The ASTER **TIR** data consist of 5 bands. It represents a multispectral thermal imaging data. The TIR images are useful for defining surface temperature and silica contents, although their resolution of 90 m.

The ASTER VNIR subsystem includes a combination of nadir looking and backward looking bands, covering the same near infrared spectral range. These near infrared bands (assigned to bands 3N and 3B) are designed for the generation of along-track stereo-image pairs. They are used for digital elevation models (DEMs) creation and 3-dimensional stereoscopic visualization. The stereo-image pairs have a base-to-height ratio of 0.6 and intersection angle of 27.7 degrees. The DEMs are applicable in many areas as the mineral and petroleum exploration by the interpretation of geological structures on stereo-imagery, the

hydrological modeling of the drainage basins, the topographic mapping and ortho-correction, etc.

The ASTER derived DEMs have a resolution of 15 m and have the advantage that the associated VNIR and SWIR imagery is perfectly coregistered.

Geological background

The Panagyurishte ore region is part of the Apuseni-Banat-Timok-Srednogie magmatic and metallogenic belt (Popov et al., 2002). It is located 55-95 km eastern from the city of Sofia. It covers an area of about 1500 km² that includes part of the Central Srednogie and Stara Planina (Balkan) Mountains, between the towns of Pazardzhik and Etropole.

The Srednogie zone encompasses the eastern part of the Banat-Srednogie (or Appuseni-Banat-Timok-Srednogie) magmatic-metallogenic belt on the territory of Bulgaria. It extends W – E across the breadth of the country as a strip about 500 km long and 20 to 100 km width (Fig. 2). The Srednogie zone is usually divided into three parts taking into account some differences in magmatism and the type of ore mineralizations – Western, Central and Eastern ones, contoured by well-expressed NE fault zones between them. High-sulphidation epithermal deposits are an important gold resource in Eastern Europe, notably in the Bulgarian Panagyurishte region (Central Srednogie zone, Fig. 2). High-sulphidation, volcanic-hosted, epithermal deposits of economic importance, such as the Chelopech major goldcopper mine (Strashimirov et al., 2002; Moritz et al., 2003), occur in this region.

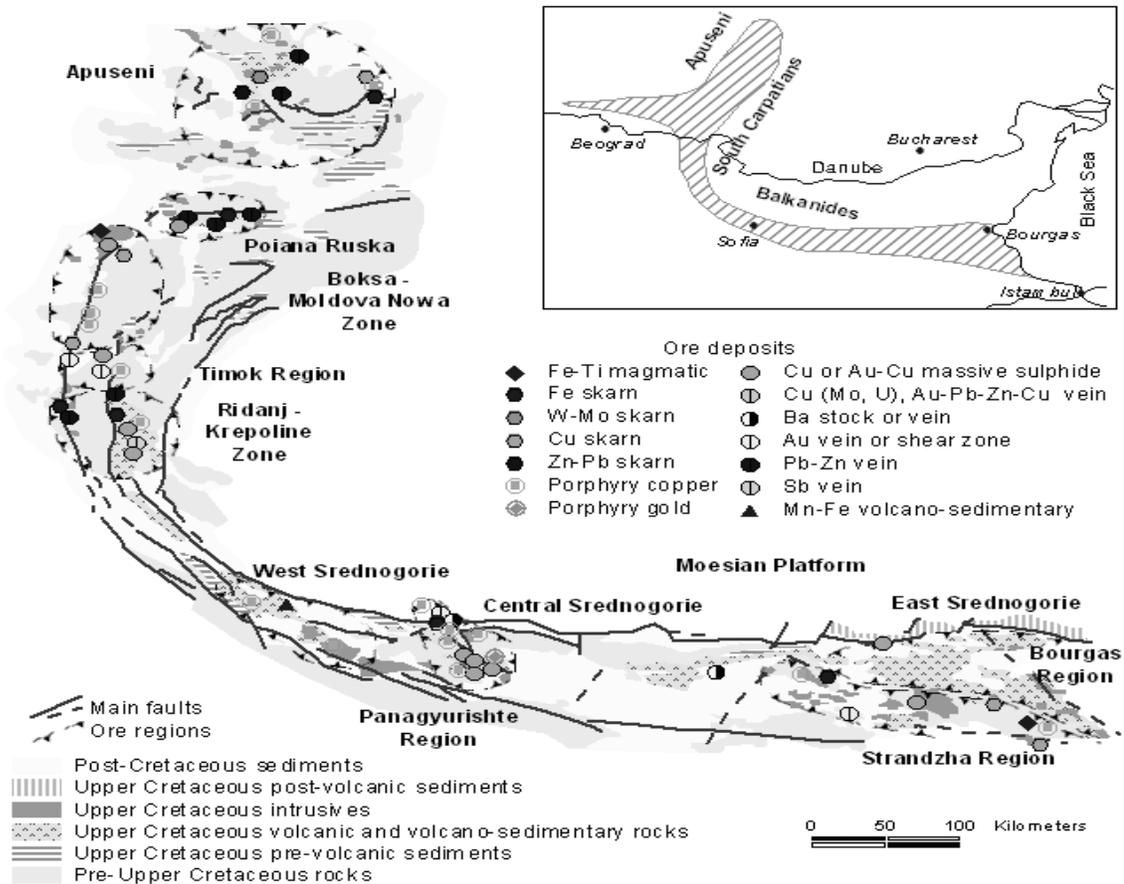


Fig. 2. Position, geology and metallogeny of Apuseni-Banat-Timok-Srednogorie magmatic and metallogenetic belt (after Popov, 1996).

The main characteristics in the geological structure of the Panagyurishte ore region are specified by the character of the complex of Upper Cretaceous magmatic and sedimentary rocks and the associated with them tectonic structures (Fig. 3).

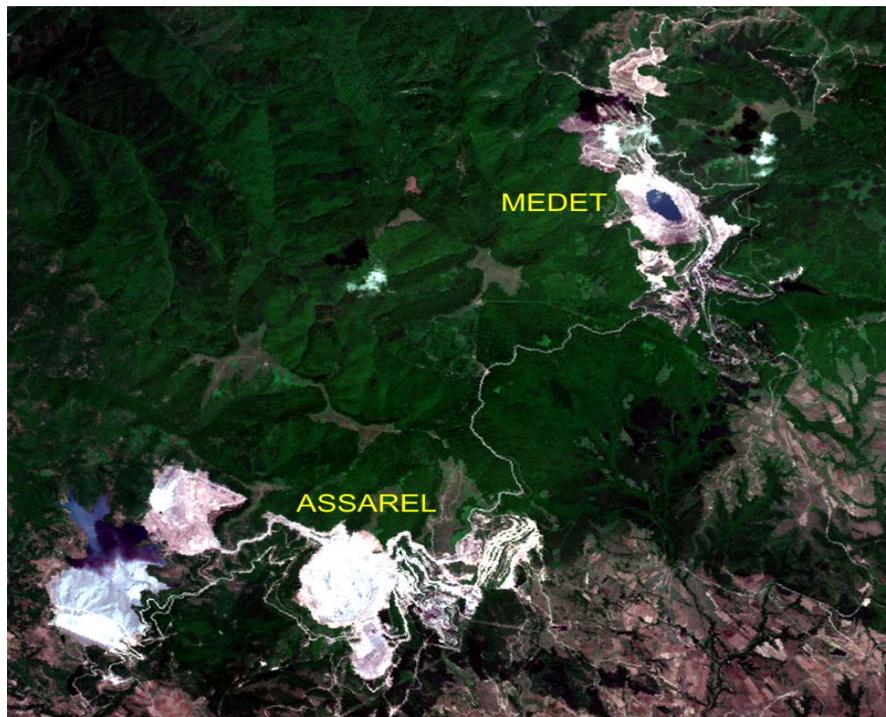


Fig. 4. ASTER natural color image of the Assarel and Medet ore deposits (Red-B2, Green- $(B1*3+B3)/4$; Blue-B1). Right- ASTER stereoscopic image of the south-western part of the Panagyurishte ore region concerning to structural discrimination.

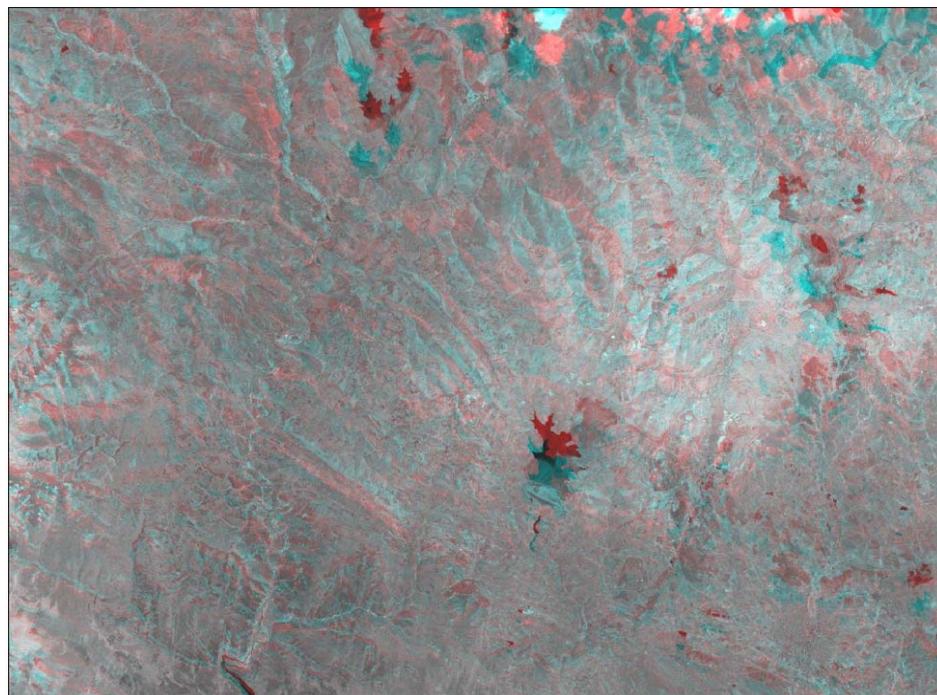


Fig. 5. ASTER stereoscopic image of the south-western part of the Panagyurishte ore region concerning to structural discrimination.

Conclusions

The features that dominates the area are several WNW-SSE trending fault segments (orientation is between 113-129°). They are defined by linear valleys and ridges as well as by linear slopes. Most probably they are strike-slip faults. Another comparatively well-defined fault system is striking NE-SW (225°). At least one of these faults is expressed as an abrupt linear front locally marked with scarps. This fault is separating recent alluvium deposits from their basement and can be interpreted as a normal fault.

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