Map geological features

Applications

General

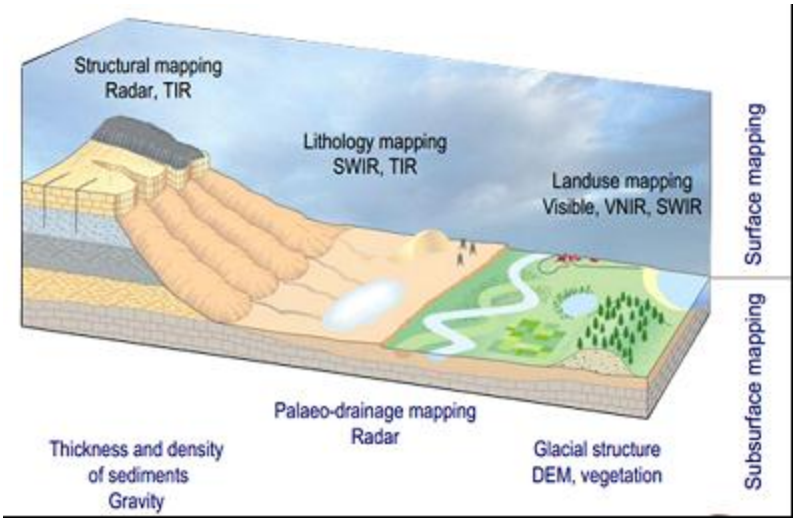
Satellite images of the Earth's surface yield important information for planning seismic surveys. Using combinations of images from different portions of the electromagnetic spectrum, geoscientists can discriminate land use, type of vegetation, lithology, elevation and surface roughness. Evaluation of these remote sensing attributes establishes risk factors for source and receiver signal quality, for vehicular and personnel access and for potential survey damage to the environment.

Remote satellite sensing within the E&P industry is not restricted to seismic survey planning, but can also find subtle hints for the presence of hydrocarbons. Applications for reservoir monitoring, such as for subsidence and for CO_2 planning and monitoring, also exist.

Since the results of satellite image analysis are put into a GIS system, including the 3D nature of the data, the results can be incorporated with subsurface information and models. Subsurface information and formation properties can be incorporated in modeling packages such as the Petrel seismic-to-simulation software(1). Integration of the surface and subsurface information into one package allows assessment of surface constraints within the context of a shared 3D space. As this article describes, such integration can provide valuable insights into a seismic acquisition program. It can help to link subsurface structure to its surface expression of faults and folds. Planning of drilling and production facilities and pipelines can account for both surface and subsurface needs, including environmental constraints.

Structural mapping

Structural mapping exploits the fact that surface geology and geomorphology are coupled to subsurface structure. At present, SAR imagery is used to identify changes in surface roughness and to detect faults, joints and fractures to improve delineation of lithological boundaries and characterise drainage networks.
In parallel, multi-spectral data in the optical and infra-red bands are used to improve the characterisation of specific lithology units. In addition, multispectral data can be used to detect areas with spectral anomalies that indicate chemical alteration of the



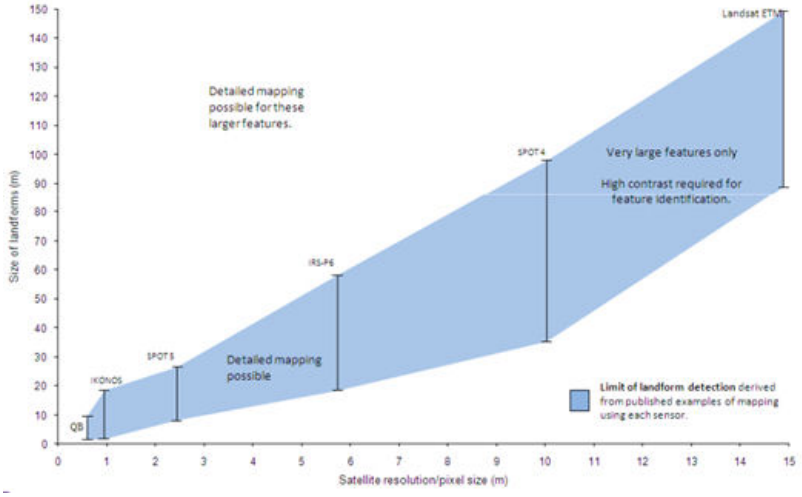
local strata caused by proximity to hydrocarbon or mineral deposits. For example, iron rich alteration products caused by hydrocarbons seeping through and reacting with over-lying sediments have specific spectral signatures (or ranges) that can be traced using multispectral sensors.Digital Elevation Models based on SAR interferometry are also used to provide geomorphological indicators for possible hydrocarbon traps.
Linear features such as folds, faults and lineaments, can be easily traced using SAR imagery. The geologist studies these surface features in order to work out what is happening to the strata below.

With continuous extension more rock beds become, the different composition of the rocks have different spectral characteristics which can be picked up on multispectral data, and the textural differences can again be distinguished with SAR.

Thus by interpreting the different indicators within the context of the inferred tectonic and erosion processes for a given area, an independent analysis of the local geological structure can be derived. This information is integrated with conventional geological information (eg low resolution maps) as different layers within a GIS to enable substantially improved interpretation and analysis.

Continuous developments in satellite platforms and sensors characteristics lead to improvements in mapping of geological features:

- increased spatial resolution brings improved interpretation and classification of landforms, improved reliability in classification and increased image complexity
- greater temporal resolution means ability to monitor ground behaviour and fewer gaps in data coverage
- high resolution topographic data improve geo and topographic correction, interpretation and classification of landforms and visualisations
- new high resolution gravity fields (e.g. from GOCE) can be used for identifying geological features, and therefore serve as useful innovative tools in geophysical exploration.



Products

Products	Source	Descriptions	Product Standards	Ref. Project
Off-the-shelf geological interpretation studies	ASTRIUM	• **East Africa Rift System**. Fully integrated geological study of the East Africa Rift System providing a consistent interpretation of the surface geology and the location of hydrocarbon seeps in the region • **East Mediterranean** • **Geological interpretation in Iraq**. Regional structural interpretation of northern and southern Iraq carried out at scales ranging from 1:250 000 to 1:50 000 in areas of structural complexity. • **Zagros fractured reservoir in Iran**. Fractured reservoir study of the Zagros Simply Folded Belt of Iran, regional synthesis of the reservoir quality of fractured carbonates.		

Success Stories

3D Mapping Data for the Indonesian Government Geological Survey			

References

Topic	Description	Keywords	Reference
Gras R and Stanford N	"Integration of Surface Imagery with Subsurface Data,"		EAGE 62nd Conference and Technical Exhibition, Glasgow, Scotland, May 29--June 2, 2000
EO-MINERS	**Report** - Earth Observation for Monitoring and Observing Environmental and Societal Impacts of Mineral Resources Exploration and Exploitation	Mining, environmental, societal impact, assessment, Geology	Bureau de Recherches Géologiques et Minières (brgm)
Geology and Mineral Analysis	**News article** with examples of remote sensing geology research	Geology, Mineral, Remote sensing	ASDI
Geological remote sensing and multispectral image processing	**Research article**	Geology, Remote sensing	KECK

Mineral Exploration Using Satellite Images for Geological Applications	**News article** on mineral exploration	Geology, Mineral	SIC
GEOSAT-AR Project, Regional Geological Mapping with Advanced Satellite Data in Argentina	**Research paper** summerising ASTER data characteristics and development of the project during its four years duration and the main goals	Geological mapping, Satellite data	FCNYM