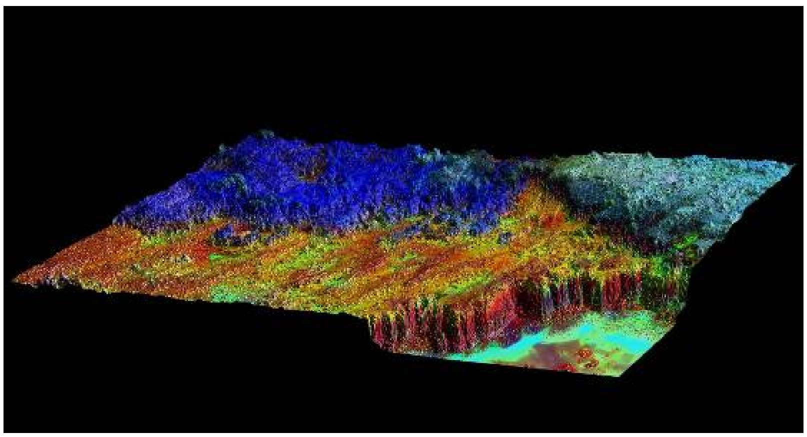
Map seismic survey operations

Applications

Map seismic survey operations

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, geo-scientists can discriminate land use, type of vegetation, lithology, elevation and surface roughness. Pre-survey 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 sensing evaluation before acquiring a land seismic survey provides input for all four parts of QHSE: quality, health, safety and environment. Data from satellite surveys give map and elevation views of features on and just below the surface, as well as giving an idea of the rock type. The risk of poor-quality data because of poor earth coupling from a seismic source and to receivers can be inferred using a rock physics model of the interpreted lithology.



Lithology map overlain on digital elevation map obtained by remote sensing. The desert area of Ghazalat has limestone heights over a sandstone plateau. A depression with a sabkha base is separated by a steep escarpment

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.

Locating dangerous terrain gives a means to protect the health and safety of survey personnel. That information, along with interpretations of terrain stability, impacts the ability to safely deploy seismic acquisition vehicles and associated equipment. Finally, remote-sensing data can identify environmentally sensitive areas and minimize the negative impact on these areas.

Satellite images of the Earth's surface have become familiar to many people through Web services such as Google Earth. However, remote sensing is more than just a map image: Satellite images have a continuous view across an area in multiple spectral bands. Typically, these include reflected radiation in the visible, infrared and microwave bands. Some satellites also obtain radar images to map tectonic elements or moisture. Time-lapse satellite images allow mapping of seasonal (or longer) changes or of subsidence.

Several satellites have surveyed the Earth's surface, with a variety of frame or viewing sizes and resolutions. Resolution varies, both by satellite and by portion of the spectral band. Although the resolution of most satellites is insufficient to discriminate individual features such as bushes or boulders, remote sensing can map out regions covered by vegetation distinct from boulder fields, because of their different spectral reflections. Since satellite images can encompass an entire land seismic survey area, this technology is a useful tool for screening the area for hazards and for planning deployment and acquisition logistics.

The most important factor affecting how a remote sensing evaluation proceeds is the terrain: whether it is flat, rocky, sandy, populated, farmed, covered with vegetation or icy (Figure Opening Art). The type of maps produced can differ greatly with each location posing different risks for land-based seismic acquisition.

In a land seismic survey, the most efficient and repeatable acoustic source is a vibrator, such as a vibroseis truck. However, vibrator trucks are large and heavy; their deployment requires careful logistical planning. In steep terrain, there is a danger of rolling over, and in soft terrains the truck can get stuck in sand or mud.

Other risks derive from the contact between a vibrator pad and the surface. Although a vibrator truck might be supported in a sabkha or dry riverbed, the crust might not sustain additional force from the vibrator. Also, soft sediments can have high attenuation of the acoustic source signal. At the other textural extreme, a hard, rock-strewn surface may also have poor coupling because the pad contacts only a few points of the highest rocks.

Evaluating risk of poor source and receiver coupling to the Earth's surface and of energy losses due to seismic-wave propagation in the near-surface is important for planning a seismic survey. These account for the majority of the degradation of the seismic signal intended for hydrocarbon exploration and reservoir characterization. Remote sensing can help develop a risk assessment because it can densely characterize the near-surface using optical and radar data.

Three case studies are available in very different types of geography.

1. A desert environment in Egypt showing the general approach to remote sensing, describing how the various spectral bands combine into useful planning information.
2. A basalt plain in Argentina.
3. Determination of glacial features in Austria.

Mark Andersen – review A. Laake; *Satellite Sensing: Risk Mapping for Seismic Surveys,* Oilfield Review, Winter 2008/2009

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Products

Products	**Source**	**Descriptions**	**Product Standards**	**Ref. Project**
Global seismic hazard map	GSHAP			GSHAP

Success Stories

Satellite imagery for seismic surveys			
? Unknown Attachment			

References

Topic	**Description**	**Key words**	**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 summarizing ASTER data characteristics and development of the project during its four years duration and the main goals	Geological mapping, Satellite data	FCNYM