3-D Seismic textural analysis

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ABSTRACT

This paper proposes methods to infer rock type from the texture of 3-D seismic data. We propose to borrow techniques from remote sensing and adapt them to the interpretation of 3-D seismic data. We will use illumination shading with shape, pattern, and texture analysis to analyze 3-D seismic time-slices and horizons. The resultant maps and knowledge of the seismic expression of geologic type will be used to estimate rock type.

OVERVIEW

The remote sensing community has long used the shape, pattern, and texture of features on images to infer characteristics of target regions (Avery and Berlin, 1992; Koger, 1993). Indications of surface cover type (Van den broek and Groot, 1993) and soil or rock composition (Hough, 1993) can be found. Textural analysis can be especially powerful as an aid in geological mapping (Sabins, 1993) as some rock types display characteristic striations, pits, speckling, or smoothness. An example of a shuttle imaging radar (SIR-A) image of an area in Indonesia and its resultant interpretation from texture is shown in Figures 1 and 2. Remote sensed images, from radar, infrared, or visible parts of the spectrum, have thus been useful in oil and gas exploration (Dekker, 1993).

It appears that some of the methods and software from the remote sensing industry may be directly applicable to the analysis of 3-D seismic data. Useful packages include the ER Mapper (Earth Resource Mapping Co.) which has a wide variety of image processing algorithms and interpretational features. In fact, many remote sensing images have resolution (pixels) that are about 30m x 30m, similar to the bin size in seismic analysis. Surface geological features that are apparent on remote-sensed data may have subsurface analogues that are evident on seismic horizon maps or time slices.

We propose to analyze 3-D seismic unconformity surfaces, horizons, time slices, and slant sections to find rock type. We intend to pick the amplitudes and isochrons of surfaces as the textures to be considered. Illumination and instantaneous attributes will be used to enhance seismic features and geological texture. From these topographic and reflectance maps we will attempt to infer rock type.

REFERENCES

Avery, T.E. and Berlin, G.L., 1992, Fundamentals of remote sencsing and air photo interpretation, 5th ed., Macmillan Publ. Co.

Hough, H., 1993, Satellite imagery entices mining firms to Argentina: Earth Observation, 2, 9, 24-28.

Koger, D.G., 1993, Mature oil and gas areas: A multi-data approach to exploration: Earth Observation, 2,4, 52-54.

Sabins, F. F., Jr., 1993, 3rd ed., Remote sensing laboratory manual: Soc. Explor. Geophys.

Dekker, F., What is the right remote sensing tool for oil exploration?: Earth Observation, 2, 1, 28-35.

Van den broek, A.C. and Groot, J.S., 1993, Intercalibration of satellite and airborne SAR: A comparative study of ERS-1 and AIRSAR/PHARS SAR data: Can. J. Remote Sens., 19, 3, 209-217.

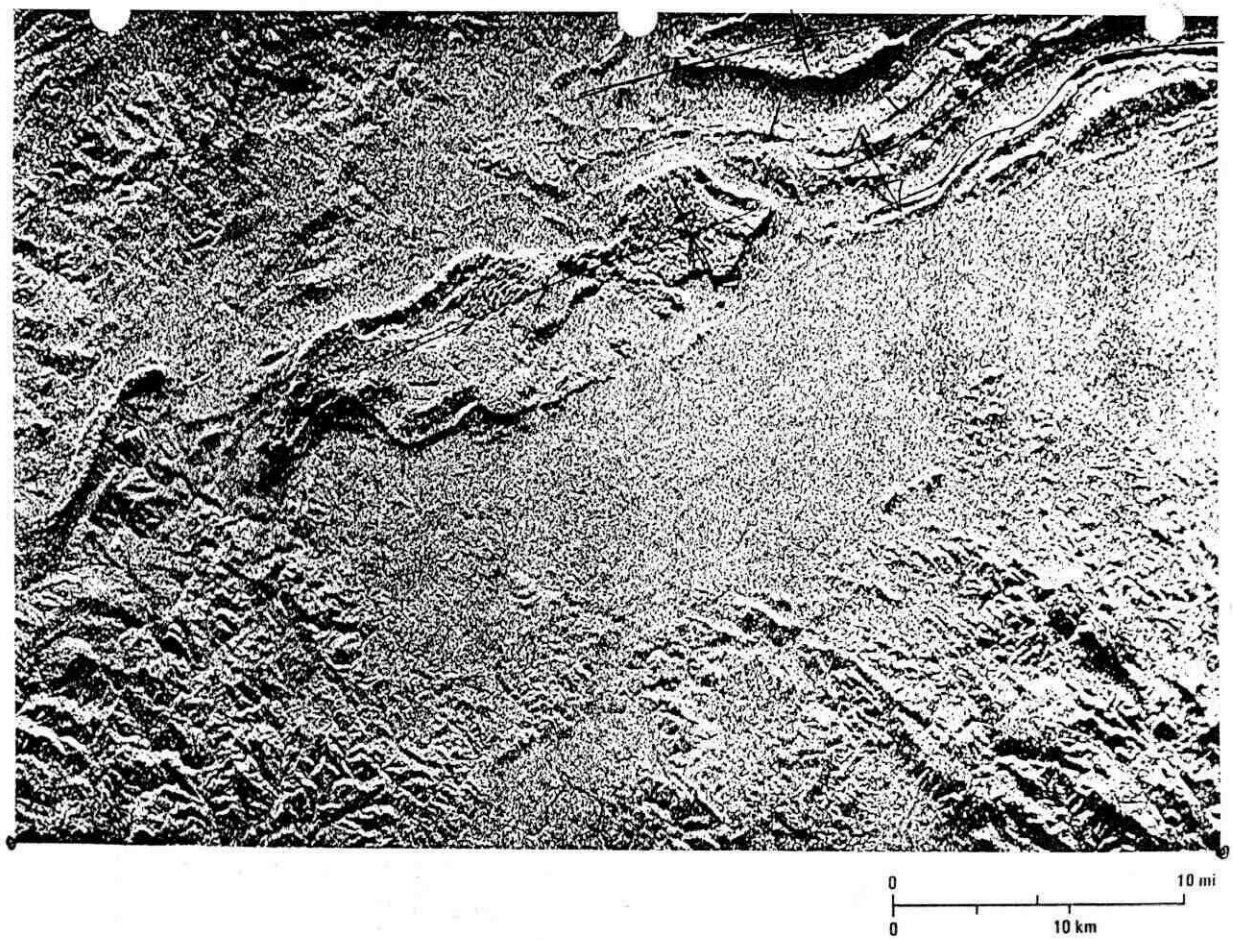

FIG 1. An SIR-A image of northeastern Kalimantan, Indonesia (from Sabins, 1993).

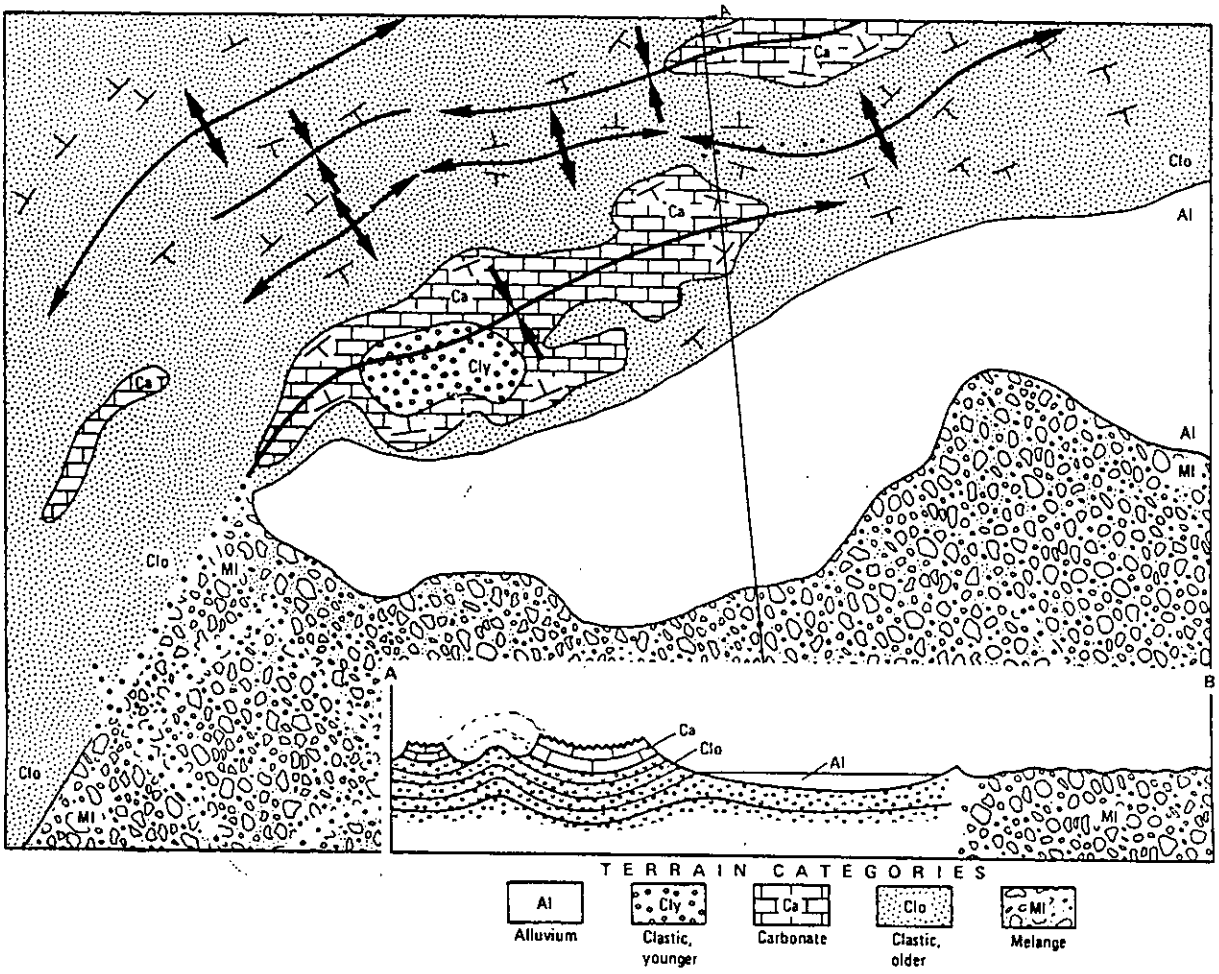

FIG 2. A geologic interpretation of the Indonesian radar image shown in Figure 1 (from Sabins, 1993).