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Textural Enhancement of a Circular Geological Feature

Subtractive box filtering and histogram equalization enhancement were used.

Introduction

A Landsat 2 scene (2984-21002) recorded on 2 October 1977 (GMT) emphasized the existence of several circular geological features. These geologic structures were less obvious on conventional panchromatic aerial photography and topographic and geological maps. Part of the scene containing the feature at 42°13′S, 172°04′E is reproduced as Plate 1a. This Landsat subscene was written out on the New Zealand Optronics C4300 Colorwrite from the Landsat Computer Compatible Tape (CCT) data using the reformatting and enhancement programs of the Physics and Engineering Laboratory (Thomas, 1977; McDonnell, 1978). A histogram equalization enhancement was used over the whole scene to emphasize the predominant native forest and agricultural areas.

Conventional subtractive box filtering was then used (Thomas, 1979) to enhance the textural information. The resultant subscene was again passed through the histogram equalization hue enhancement process and written out on the Colorwrite. This subscene is reproduced here as Plate 1b.

Subtractive Box Filtering

The relation

$$R' = R - F \times \bar{R} + C$$

is used here where

- R' is the new synthesized radiance value for the picture element (pixel),
- R is the radiance value for the original pixel,
- F is the fraction of the surrounding radiance that is subtracted from the central pixel's radiance value,
- $\bar{R}$ is the average radiance of the surrounding nearest neighbors, and
- C is an additive constant, used to avoid clipping R' at low scene radiance levels.

In this case F was set to 0.8, C to 20.0, and a matrix of 3 × 3 nearest neighbors—excluding the central pixel—was used to derive $\bar{R}$ as an arithmetic mean (following Green, 1978).

Abstract: *Subtractive box filtering is used to texturally enhance a circular structural feature recorded by a Landsat 2 image (2984-21002) over the northern part of South Island, New Zealand. The geological structure is associated with porphyry molybdenum-copper sulphide mineralization.*

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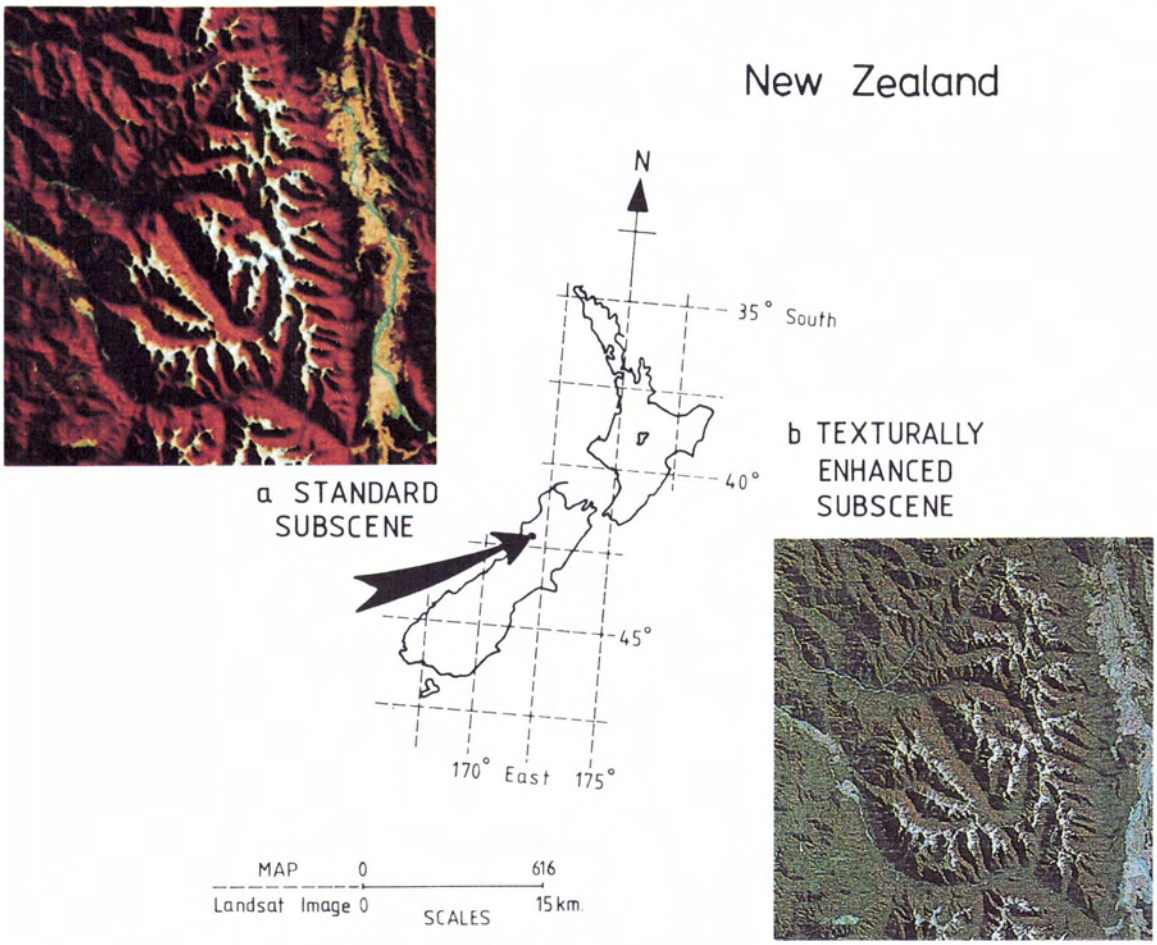

PLATE 1. CCT data for the Landsat 2 subscene from image 2984-21002; covering the circular geological feature at 42°13′S, 172°04′E. The image subscene has been written out on the New Zealand Colorwrite, using two image processing techniques: (a) histogram equalisation hue-enhancement for vegetation, and (b) subtractive box filtering textural enhancement followed by the same hue enhancement as in (a).

The textural enhancement of the CCT data was done on a nationwide IBM 370/168 and written to magnetic tape (Thomas, 1979). The tape was then read on the "in-house" Varian V76 minicomputer, using the hue enhancement programs developed by McDonnell (1978) and written out on the Colorwrite. In the work reported here the standard multispectral scanner (MSS) bands 4, 5, and 7 were written through blue, green, and red filters, respectively, to produce the positive color film transparency.

A Suggested Geological Interpretation

The circular feature (Plate 1) is perhaps the most clearly defined of fifteen similar features recognized on the Landsat 2 image (2984-21002) (Eggers, 1979). The "circular" features range in diameter from approximately 8 to 40 kilometres, with the average being close to 15 km. (The features were regarded as "circular" because their major and minor axes differed by less than 25 percent.)

Almost entirely confined to granitic terrain 320 to 100 million years old (Eggers and Adams, 1979), the structural features are suggested as being associated with ore mineralization. Significant porphyry molybdenum-copper sulphide prospects are located on or near to these features. Linear features, many of which coincide with mapped faults, do not appear to have any particular *spatial* control on the location of the prophyry type mineralization or to have significantly displaced or distorted the circular features.

Similar features on the North American Continent, also related to ore mineralization, have been described by Saul (1978). He attributed their origin to meteorite bombardment around 4,000 million years ago. For the preservation of features formed in such a manner, a stable continental crust environment must be invoked. However, the geology of Northwest Nelson indicates that this area has been one of unstable crust, at or near to a continental margin, at least since late Paleozoic time.

An origin is therefore suggested as arising from the tensional environment developed in surface crustal rocks above diapirically rising granitic magma. Surface expression of such tension could be volcanic deposits associated with caldera fracture and ring structures (faults). When exposed by subsequent uplift and erosion, the sub-volcano expression of such faults could possibly be structural features similar to those depicted in Plate 1.

Conclusions

Landsat data have here assisted in the location of possible areas deserving more detailed exploration for potential mineral deposits.

While it is difficult to quantify an improvement in visual information transfer, it is believed that textural enhancement, through subtractive box filtering in this case, has improved the delineation of the geological structure first noticed on the hue-enhanced "standard" product.

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