PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

General Discussion

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General discussion

Monica M. Cole (*Bedford College, London, U.K.*). In contributing to a discussion of the use of multispectral satellite imagery in the exploration for petroleum and minerals covered by Mr Peters I wish to emphasize four points, some of which are relevant also to statements made by Dr Curran in his presentation.

The first point is that remotely sensed imagery is a tool and its interpretation a technique to be used as appropriate and integrated with other techniques in mineral exploration. Mr Peters has reviewed the potential of multispectral satellite imagery and emphasized its value in initial reconnaissance studies notably for the identification of geological structures and lithologies. I would emphasize also its value at more advanced stages of exploration when reinterpretation of imagery at large scales and with reference to ground truth data can yield valuable information.

My second point, which follows naturally from the first, is that effective interpretation of remotely sensed imagery requires an appreciation of the geographical environment as well as the geological environment. It is reflectances from the components of the geographical environment that produce the colours and tones seen on the colour composites generated from Landsat imagery. Except in arid areas largely devoid of plant cover, in natural terrain reflectances from vegetation dominate over those from soils and bedrock. Their contribution increases with increasing density of cover. The reflectances from different types of vegetation and from individual plant species, however, vary greatly, depending on the geometry of the canopy, the colour of foliage, the size, shape, angle, etc., of leaves, and the turgidity, water content and nutrient status of leaf cells. It is the differences in vegetation cover producing differing reflectances that permit the discrimination of lithologies and identification of structures on colour composites generated from Landsat imagery. In some areas, however, any or all of relict laterite, superficial cover, former and ephemeral drainage systems, and other physiographic features that are the legacies of geomorphological processes, complicate relations. These need to be understood for effective evaluation of imagery for geological purposes. In this context there is no substitute for field investigations, which are essential for the acquisition of ground truth data needed for effective evaluation of imagery.

The third point that I wish to emphasize is that the relevance of the interpretation of remotely sensed imagery for specific studies varies for different environments. Its value for terrain analysis, geological mapping and mineral exploration in semi-arid and arid lands is acknowledged. Less is known of its potential for studies of humid terrain. I believe, however, that even in mountainous country clothed with tropical and subtropical forests the interpretation of multispectral imagery could yield valuable geological and geographical information provided that sufficient ground truth data are obtained to permit an understanding of the environmental conditions.

Finally, my fourth point is the need to discriminate the significant from the unimportant both in studies of imagery and in the field.

[Professor Cole illustrated her points from four pairs of slides.]

The first pair of photographs shows a large-scale colour composite and an interpretation thereof of a subscene from Landsat imagery of the mountainous humid subtropical Tengchong

area of western Yunnan, China, located in a mobile belt characterized by volcanic activity at the collision zone of the Indian and Eurasian plates. Differing reflectances from different types of vegetation cover and different tree species delineate the Mount Ma An volcano and discriminate lavas of differing age and degrees of weathering; and the very bright reflectances (actually occurring in all four MSS bands) that reveal zones of geothermal activity characterized by hot sulphur springs, along fault lines in the area south of the volcano, are noteworthy. The second pair of slides shows an area north of Tengchong. One slide, a colour composite, displays circular structures and complex fault systems that reveal areas where granite has intruded overlying limestone to produce zones of potential multi-metal mineralization. The second, a colour photograph of the terrain, shows a series of geobotanical anomalies over gossans that mark a mineralized belt from which semi-quantitative analyses of soil and rock chip samples indicate the presence of copper, lead, zinc, silver and tin. The imagery revealed the structures; field investigations were needed to identify the vegetation anomalies, gossans and mineralized zones. The third pair of slides shows an enhanced conventional Landsat colour composite and one subjected to rotational procedures of a small area within the Lake Eyre drainage basin of Australia, where there are complex patterns of ephemeral and former drainage channels. These can be identified on the imagery and must be considered in the interpretation of geochemical data for exploration purposes. A greatly enlarged colour rotated composite of part of the area demonstrates how fence lines identifiable on the imagery can assist location of other features both on the imagery and in the field. The final slide carries a warning. An enhanced colour composite of a Landsat subscene covering an area south of Lake Ngami in Botswana, it shows a series of circular features that were initially identified on conventional black and white air photos as prospective kimberlites. Field studies revealed that the vegetation over these features was indicative of acid rocks, not kimberlites. Nevertheless some were drilled. This disclosed that the circular features represented the tops of hills in the Cave Sandstone landscape that existed before the outpouring of the Stormberg lavas that cover the area today. Mr Peters commented on the identification from Landsat imagery of other circular features important in petroleum exploration. Many important structural features can be identified on remotely sensed imagery. The significant must be distinguished from the unimportant, and this requires field investigations.

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