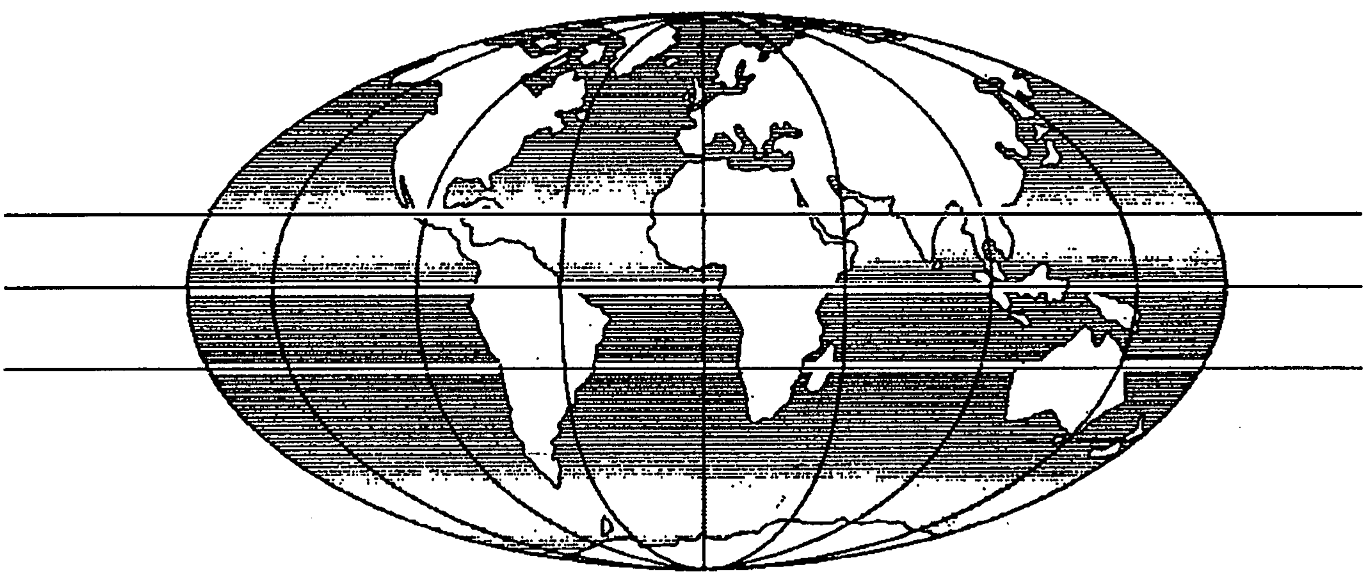
TRANSPORT RESEARCH LABORATORY

ODA

Reprint

TITLE **Application of Remote Sensing to Material Resource Location in Developing Countries**

by **R J Stone**



Overseas Centre
Transport Research Laboratory
Crowthorne Berkshire United Kingdom

STONE, R J, 1989. Application of remote sensing to material resource location in developing countries. In: Remote Sensing for Operational Application. *Technical Contents of the 15th Annual Conference of the Remote Sensing Society, University of Bristol, 13-15 September 1989*. Nottingham: The Remote Sensing Society.

Application of Remote Sensing to Material Resource Location in Developing Countries.

Rosemary J Stone
Overseas Unit
Transport and Road Research Laboratory (TRRL)
Old Wokingham Road, Crowthorne, RG11 6AU, England.

Abstract

This paper describes part of a research project in the Overseas Unit of the Transport and Road Research Laboratory in which remote sensing imagery is being used in the search for construction materials in the developing world. Landsat MSS and TM imagery, together with SIR-A data, have been used successfully to identify potential material resources in Botswana and Tunisia. Similar studies will be undertaken in other areas to assess the universal applicability of the data.

Introduction

Large quantities of aggregate are required for highway construction projects in all areas of the world. In developing countries, where road construction budgets are limited, the need to find local sources of materials is an important project consideration. Naturally-occurring materials, often the products of terrestrial weathering and erosional processes, are an ideal source of aggregate. Therefore, searches are made for landforms known to produce or contain such materials.

In the field, a geomorphologically-trained eye is able to identify environments where gravels may occur. Field investigation is usually preceded by examination of topographical, geological and land system maps, providing they are available for the area concerned. However, in remote areas, maps of the required scale frequently do not exist. It is in such situations that remote sensing can offer the engineering geologist a valuable means of acquiring information about a given environment.

The Search for Construction Materials in Botswana

A decision by the government of Botswana to upgrade an existing road across the Kalahari desert from Gaborone to Ghanzi poses considerable problems for construction, as no obvious sources of materials can be found in the area. In South Africa hard calcretes are well known for their construction properties but softer calcretes are far more abundant in the central Kalahari. Both types of calcrete can be found in pans, depressions and inter-dune hollows. The best deposits occur within the raised rim, or platform, surrounding the larger pans but these pans are by no means ubiquitous.

Paper presented at the 15th Annual Conference of The Remote Sensing Society, University of Bristol, 13–15 September 1989.

A research programme was designed to assess the potential of different remote sensing techniques to identify calcrete-bearing landforms along the route corridor. Test strips of colour and multispectral aerial photography were flown. It was found that the majority of the landforms in the area could be distinguished on standard black and white aerial photography. However, the spectral separability of Landsat MSS data and colour aerial photography was needed to determine the full range of calcrete-bearing landforms from pans to grey sands. Pans devoid of vegetation could be distinguished easily on digitally-enhanced Landsat MSS imagery, but grassed pans of any size were difficult to distinguish as they had little spectral contrast with the surrounding plains (Lawrance and Toole, 1984). Further research is being undertaken to assess the capability of higher resolution Landsat TM data in the quest for calcretes and quartzite deposits along the same route corridor.

Material Resource Location in Central Tunisia

The value of conventional remote sensing techniques in materials location cannot be disputed. However, as products of weathering processes often have similar spectral responses to in situ products of erosion, there can be problems associated with aggregate identification. The sensitivity of radar to variations in surface profile of the order of a few centimetres makes it an ideal tool for the discrimination of aggregate deposits and sand areas, which will have a direct relationship with image tone. It is of particular importance in arid or semi-arid areas where the presence of vegetation is not sufficient to alter the roughness profile of the surface significantly. Therefore, the resulting radar return is a function of the materials or bare surfaces.

Shuttle Imaging Radar-A imagery was used to identify various materials that could be used for construction projects in central Tunisia (Stone, 1988). Calcretes and alluvial fan deposits were discriminated easily on account of the diffuse backscatter produced by their exposed stoney surfaces. The response from both these areas was in contrast to the dark tone produced by the smooth alluvial deposits of the valley floor and sebkhas.

Analysis of a digitally co-registered SIR-A/Landsat TM product of the Tunisian study area revealed additional information about the location and nature of potential construction materials. Indeed, when data from the visible, infra-red and microwave parts of the spectrum are used together they provide complementary information about an area or deposit, allowing both surface form and spectral characteristics to be determined. Similar conclusions were made by members of the South Australian Highways Department who used a combined radar-Landsat product for identification of materials along the Pimba-Olympic Dam road in South Australia (Mann, 1986; Butcher et al, 1987).

Conclusions

Analysis of remote sensing data of field areas in Botswana and Tunisia has revealed the value of data recorded at various wavelengths for the identification of suitable construction materials. Site investigation will still be required to determine chemical characteristics or engineering properties, but geomorphological analysis of remote sensing data can certainly help in the location of material resources. It is hoped that further work within the Overseas Unit will extend these results into other areas, thereby fully exploiting the complementary information content of remote sensing imagery recorded across the electromagnetic spectrum.

Ackowledgements

The work described in this paper is part of the research programme in the Overseas Unit at TRRL and is puplished with permission of the Director. Any views expressed are not necessarily those of the Department of Transport, nor the Overseas Development Administration. Financial support for the Tunisian study came from the Natural Environment Research Council under Research Studentship GT4/84/GS/22 (Durham University). Radar Imagery was supplied by John Ford at JPL (SIR-A) and Philip Rebillard at SEP, Paris (Seasat).

References

Butcher M J, Mann D J and Harvey W G, 1987. Application of Synthetic Aperture Radar (SAR) to Materials Search. Pimba-Olympic Dam. South Australian Highways Department Report No. MS 42-1 47pp.

Lawrance C J and Toole T, 1984. The Location, Selection and Use of Calcrete for Bituminous Road Construction in Botswana. TRRL Laboratory Report 1122. 47pp.

Mann D J, 1986. Highway Engineering and Remote Sensing. In: Transport and Planning; Proceedings of the 13th ARRB - 5th REAAA Combined Conference, August 1986. Vol 13 No 8 pp109-118.

Stone R J, 1988. Radar Remote Sensing of a Semi-arid Environment: a Case Study in Central Tunisia. Unpublished PhD Thesis, University of Durham, Department of Geography. 2 volumes, 424pp.