Assad Iranpanah, Ph.D.
University of Tehran
Tehran, Iran

Geologic Applications of Landsat Imagery

Landsat MSS band 7 imagery was employed to delineate major geologic features in north-central Iran.

Introduction

The application of Landsat images for general reconnaissance studies of surface geology and particularly for delineation of major geologic features is gaining favor. The images are extremely valuable in hard-to-reach, underpopulated areas of the world where field work is difficult or impossible. Field-reconnaissance preparation can be improved by using the data obtained by remote sensors. Extraction of detailed information from the data, however, is more difficult than the detection or delineation of gross features. This brief report gives the results of analysis of an area with which the author is familiar.

The study area is in north and north-central Iran (Figure 1). The northern part of the area includes such major geological features as Alborz Mountains, which are not considered for comparison in this study (Figures 2 and 3). The southern part of the area constitutes the north-central part of the Iranian Plateau. In this area a major east-west-trending fault and several minor faults displaying shear patterns are observable for the first time. Also present in this area are two depressions, the Daryacheh-ye-Namak (in this paper called the Kashan Playa) and the Hoze-Soltan (called the Qom Playa) of Neogene-Quarternary age, in the eastern and western parts of the study area, respectively.

FIG1. Index map showing study area.

Interpretation of Images

Three Landsat I multispectral scanner (MSS) band 7 images (Figures 4 to 6) at a scale of 1:1,000,000 were used for this study (1044064347, 5 September 1972; 1044064401, 5 September 1972; and 1295063917, 14 May 1973). The three images were interpreted by visual techniques (Images I, II, and III).

Surface geologic features seen on Image I (Figure 4) include one major fault, which is found to be more extensive and branched as compared with the structures identified by previous workers (Stocklin and Nabavi, 1972). This fault, trending east-southeastward, has been delineated clearly on Image II (Figure 2). This is the first time that such a fault has been delineated clearly in this region, and the first time that this fault has been extended to the east (Figures 2 and 3).

In the northern part of the image, another fault trends in the same general direction as the above, but it is not traceable to the east. Other small faults, forming shear patterns and which are associated with volcanic rocks, have been identified on the images.

It is interesting to note that boundaries of tonal variation are not always satisfactory or accurate guides for delimiting major rock types on the images. A smooth and fine outer contact could be mistakenly depicted in-

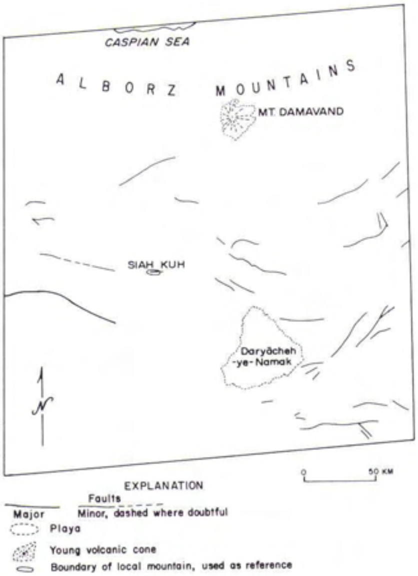

FIG. 2. Structural-lineament map of study area (modified from Tectonic Map of Iran: Stocklin and Nabavi, 1972).

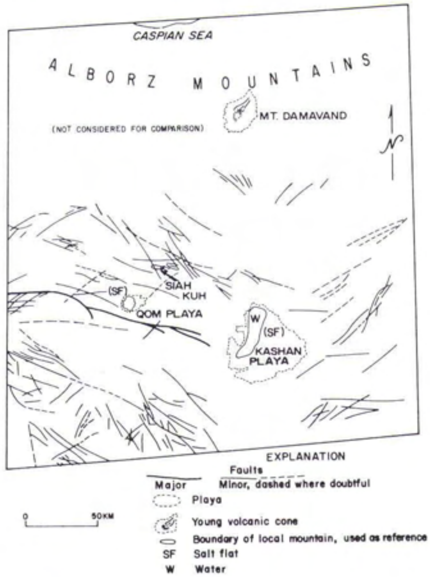

FIG. 3. Structural-lineament map of study area interpreted from Landsat images.

stead of the actual coarse and rough inner contact of the volcanics and adjacent rocks. The dark area between the two boundaries is due to the coloring effect of outwash material in the downslope direction. The contacts of the volcanic rocks of the area have not been delineated for the above reasons.

Several linear features, interpreted as fractures, also have been observed and delineated in the area. Most of these had not been picked up from aerial photographs (at an approximate scale of 1:55,000) by previous workers (Figures 2 and 3).

The snow-capped peaks of Mount Damavand and the distinct non-conformity produced by volcanic flows overlying younger country rocks are depicted (image I and Figure 3). However, the shape of the cone of Mount Damavand, which has been traced from Image I (Figure 4), appears to be different than reported by previous workers (National Iranian Oil Co., 1959; Stocklin and Nabavi, 1972).

The Kashan Playa (salt flat), or Daryacheh-ye-Namak (Stocklin and Nabavi, 1972), forms a distinct depression in the east-southeastern part of the area; this feature was mistakenly called the Qom Playa by Krinsley (1974). The Kashan Playa is part of the Qom-Ardakan Depression (Stocklin and Nabavi, 1972), whereas the Qom Playa (Hoze-Sotan) is approximately 35 km north of the city of Qom on the west side of the road from Tehran to Qom in Qom Basin. However, the Qom Playa was not shown on the Geological Map of Iran (National Iranian Oil Co., 1959), on the Tectonic Map of Iran (Stocklin and Nabavi, 1972), nor in Krinsley's publication (1974).

The Qom Playa (salt flat) can be observed by the naked eye on LANDSAT Image II (Figure 5). This is considered one of the major findings in this study, using Landsat images with an approximate scale of 1:1,000,000 (Figures 2 and 3).

At the eastern edge of Image II (Figure 5) a large part of the Kashan Playa is distinguishable by its light-gray tone. This feature is an ephemeral salt lake (playa). A patch of elongated, darker tone is present, which is interpreted as representing the water level in September 1972.

A greater amount of water appears to be present in Image III (Figure 6), taken in May. The general location of the water body, as indicated in Image II, would be consistent with the fact that May is the high-water season and September is the low-water season. Monitoring the effect of seasonal variations on the extent and levels of surface water would be of great importance to the study of ground-water systems and supplies. This could be done by studying images taken at various times.

It is concluded that in areas such as the Alborz Mountains, in the northern part of the study area, which are tightly folded and faulted, the delineation of linear features

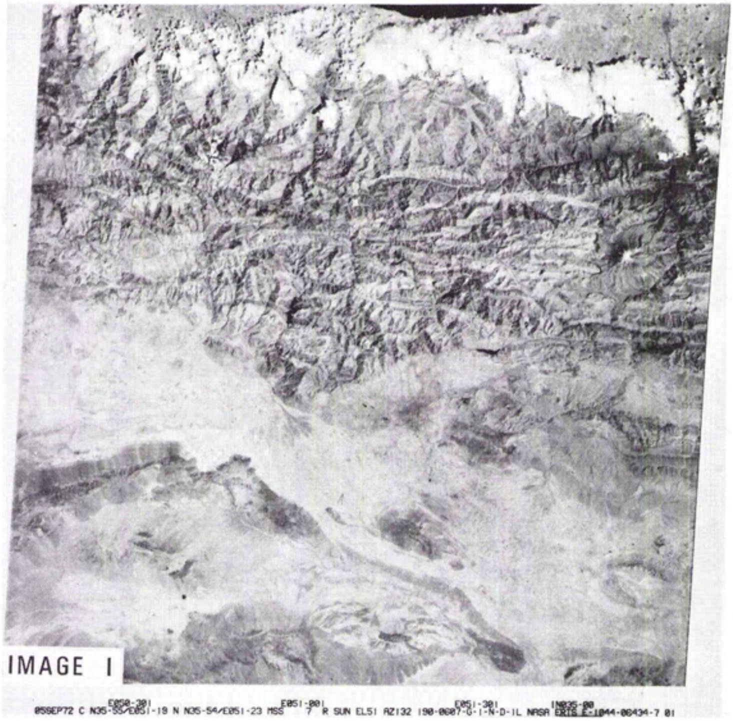

FIG. 4. Landsat MSS band 7 image #1044064347, 5 September 1972 (Image I).

FIG. 5. Landsat MSS band 7 image #1044064401, 5 September 1972 (Image II).

FIG. 6. Landsat MSS band 7 image #1295063917, 14 May 1973 (Image III).

such as faults from Landsat images is virtually impossible. This is probably due to the fact that, in areas of high relief and rough topography, geological features tend to be more undulating than linear, and are likely to follow deep erosion patterns along extensive valleys and sharp crests.

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