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GEOLOGICAL OBSERVATIONS OVER ISRAEL AND VICINITY FROM LANDSAT AND SKYLAB IMAGERY

GENERAL

Israel is located a unique geological setting — a sedimentary area bordering the Arabo Nubian massif, and containing the Dead Sea-Jordan graben which is the northern extension of the East African Rift system. Israel thus effords the study of the effects of rift formation on the surrounding sedimentary areas. At the same time, since Israel and the neighboring areas are geologicaly well mapped, with the availability of space imagery they have become an excellent proving ground for evaluating the efficacy of the use of space imagery for geological mapping.

SPACE IMAGERY

Good coverage of Israel and neighboring areas is available from ERTS-1 (now called LANDSAT-1) and there was also one passage covered by Skylab. ERTS-1 data is multispectral scanner imagery (MSS). This data is available in four spectral bands of which MSS 6 (red-infrared) and MSS 7 (infrared) were found to be most useful for geological mapping.

The two main differences between ERTS-1 and Skylab data are the much better resolution of the Skylab data and the direction of lighting.

GEOLOGICAL SETTING

In most of Israel sedimentary rocks are exposed. These rocks are mainly light coloured carbonate rocks (lhalks, limestone, dolomite) of Middle and Upper Cretaceous (Cenomanian, Turonian, Senionian) and Tertiary

(Palaeocene, Eocene, Oligocene) ages. The Coastal Plain and other low lying areas are covered by Upper Tertiary and Recent sediments, mainly sands and loams. Outcrops of Palaeozoic and Lower Mesozoic rocks occur only in isolated areas where folding, faulting and subsequent erosion uncovered older rocks.

Crystalline rocks (granite, metamorphic rocks) occur in the vicinity of Eilat and in Sinai on either side of the Gulf of Eilat. The crystalline rocks are the northernmost exposures of the Arabo Nubian massif. The crystalline rocks are dark coloured and are intruded by sets of intersecting dykes. They are extensively faulted in several directions.

Volcanic rocks occur in northern Israel in the form of Pliocene basalt flows which cover parts of Lower Galilee and adjacent areas in the Golan. Several extinct volcanoes are located in these areas.

The structure of Israel and its major morpho-tectonic divisions were formed by a sequence of tectonic events which began in Upper Cretaceaus times. Initially the area was folded into a series of northeast southwest trending asymetrical anticlines and synclines which are still preserved in the Negev. Central Israel was uparched and the Dead Sea area was depressed. The tectonic movements culminated in Pliocene times by large scale faulting which formed the Dead Sea-Jordan graben and associated fractures such as the fault blocks of Galilee and the Yizreel depression. The main faulting movement in the rift is believed to be strike slip in a north south direction [1] which was associated with the breakup of the Arabo-Nubian massif and the opening up of the Red Sea.

SPACE IMAGERY AND GEOLOGY

One of the main advantages of space photography is the coverage of wide areas under equal lighting conditions. This is by far superior to a mosaic of conventional aerial photographs [2]. Under these conditions regional features stand out and in addition smaller details can be discerned. The following examples are shown to illustrate the use of space imagery.

Figure 1 is an ERTS-1 photo of the Dead Sea Rift Valley from the Gulf of Eilat to just south of the Dead Sea.

As can be readily seen in this illustration the Pre-Cambrian outcrops stand out as dark areas near Eilat on the west side of the graben. On the east side af the graben the Pre-Cambrian outcrops extend much further north. The main intrusions and the direction of faulting within the Pre--Cambrian complex are clearly seen. Note the somewhat lighter Palaeozoic rocks outcropping east of the crystalline rocks on the east side of the graben. These are followed further east by light coloured Upper Cretaceous rocks. The eastern boundary fault of the graben stands out

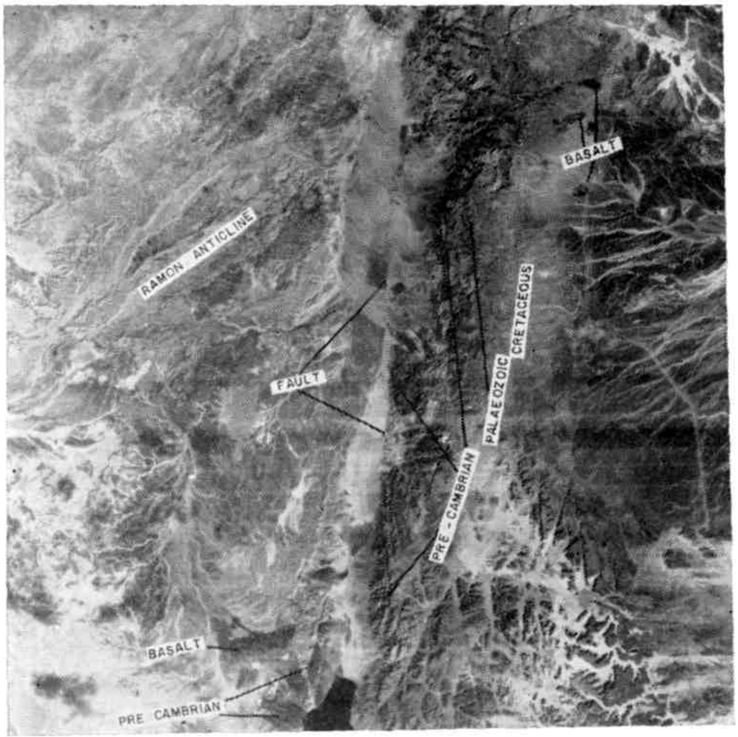

Fig. 1. Landsat image of the Dead Sea Rift Valley

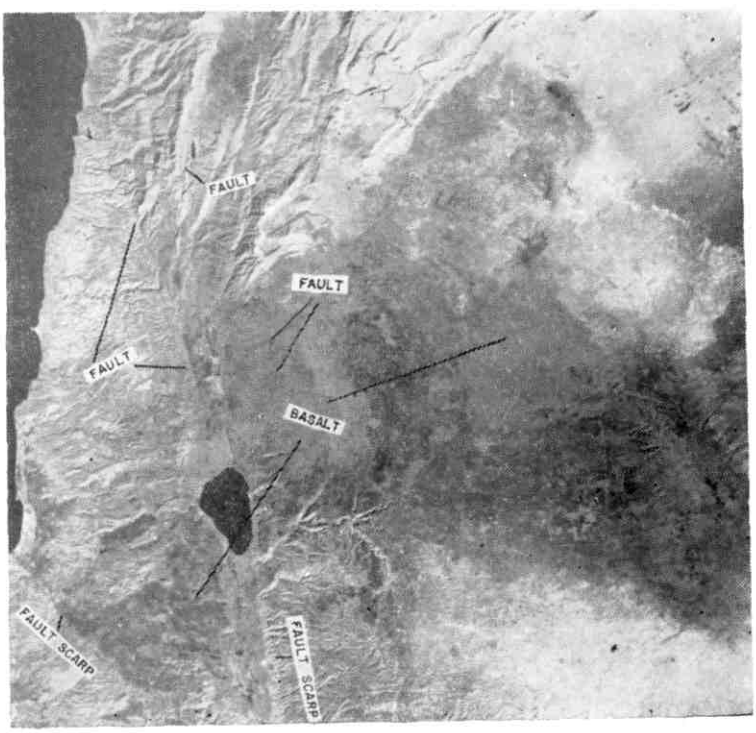

Fig. 2. Landsat image of Northern Israel, parts of Southern Lebanon and Syria

Fig. 3. Skylab image of parts of Galilee and the Golan Heights

very clearly while within the graben a major can be seen, cutting across the young sediments forming the graben fill.

West of the graben, in the northern portion of Figure 1, three major anticlines can be seen, the largest and southernmost of which is the Ramon anticline. All three anticlines have been breached in their crestal area by erosion which caused the formation of erosional cirques. Within the cirques darker coloured Triassic and Jurassic rocks are exposed. Note the dark exposures of the Pre-Cretaceous basic intrusion in the Ramon anticline.

In Figure 2 another ERTS-1 imagery is shown covering Northern Israel and areas of Southern Lebanon and Syria. The main lithologic unit which can be recognized here is the basalt cover of the Golan and Lower Galilee. Some extinct volcanoes can be seen in the Golan.

The main tectonic features which can be seen are the Jordan graben and its boundary fault scarps. The change of direction of the graben in Southern Lebanon to NNE-SSW stands out very clearly. Some faults associated with this system, such as the Rum fault extend a long way into Southern Lebanon. Note the change of direction of the Palmyrid fold system extending from Mt. Hermon east from the roughly N-S trend of the Anti-Lebanon.

The Carmel block and its eastern boundary fault and the east west fault system of Galilee can be clearly seen.

In Figure 3 part of the area of Figure 2 is shown in a Skylab photograph. As can be seen the resolution of this picture is much better than that of Figure 2 but the main difference is in the angle of lighting. The oblique lighting coming from the west causes some striking effects. The Jordan rift fault scarp stand out beautifully as do the volcanic craters of the Golan. The basalt areas are clearly seen. In addition slight changes in colour represent lithologic differences. The light coloured Eocene and Senonian chalks are clearly separated from Turonian-Cenomonion limestones and dolomites as can be seen in the bottom left of the figure. Small tectonic features such as the Galilee fault structure can be seen (centre left of the figure).

CONCLUSIONS

Due to the inherent advantages which space imagery possess, namely the coverage of wide areas under equal lighting conditions and the separation into spectral bands which can be composited and otherwise processed to bring out desired detail, space imagery can provide a powerful tool for geological mapping. The examples shown here demonstrate that gross lithologic units can be discerned and that structural features can be mapped. In areas which have not been mapped in detail space imagery is an invaluable tool for geological mapping.

REFERENCES

[1] FREUND R., GARFUNKEL Z., ZAK I., GOLDBERG M., WEISSBROD T., DERIN B., 1970: *The Shear Along the Dead Sea Rift*, Royal Soc. London Phil. Trans., Ser. A V. 267, p. 107—130.
[2] LOWMAN, P.D., 1971: *Geologic Uses of Earth Orbital Photography*, NASA Goddard Space Flight Center Report X-644-71-359.

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OBSERWACJE GEOLOGICZNE Z TERENU IZRAELA I OKOLICY NA PODSTAWIE OBRAZÓW LANDSAT i SKYLAB

Streszczenie

Obrazy satelitarne dają najlepsze wyniki analityczne w obszarach pustynnych, gdzie pokrywa roślinna nie przesłania struktury geologicznej. Dlatego dobrym obszarem badań jest strefa Wschodnioafrykańskiego Rowu Tektonicznego i jego przedłużenie w postaci Rowu Jordanu i Morza Martwego.

Obrazy satelitarne (ERTS i LANDSAT) oraz fotografie kosmiczne (SKYLAB) ujawniają wiele szczegółów geologicznych, trudnych do obserwacji naziemnej. Budowa geologiczna, linie uskoków, strefy wulkaniczne, fałdy asymetryczne, antykliny, synkliny oraz wiele drobnych szczegółów są bardzo wyraźnie widoczne na fotografii ze SKYLABA. Uzyskana plastyczność obrazu jest wynikiem odpowiedniego oświetlenia słonecznego w stosunku do płaszczyzny orbity satelity.

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LES OBSERVATIONS GÉOLOGIQUES DU TERRITOIRE D'ISRAËL ET DE SES ENVIRONS D'APRÈS LES IMAGES DE LANDSAT ET SKYLAB

Résumé

Les images de satellites donnent les meilleurs résultats analytiques des régions désertiques où la flore ne cache pas la structure géologique. C'est pourquoi la région du Fossé Tectonique Est-Africain et son prolongement en forme du Fossé de Jordan et de la Mer Morte sont très intéressants pour les recherches. Les images de satellitas (ERTS et LANDSAT) et les photos spatiales (SKYLAB) font connaître beaucoup de détails géologiques, difficiles, aux observations terrestres. La structure géologique, linges de failles, plissements asymétriques, anticlinaux, synclinaux et beaucoup de details sont spécialement nets sur les photos de SKYLAB. La plasticité obtenue de l'image est le résultat de l'éclairage de soleil par rapport au plan de l'orbite de satellite.