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SPACEBORNE RADAR FOR GEOSCIENTIFIC APPLICATIONS IN NORTH CHINA

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The Shuttle Imaging Radar-A and -B (SIR-A and SIR-B) carried on the Space Shuttle Columbia in November 1981 and the Challenger in October 1984 acquired images of test sites of North China. The Russian ALMAZ SAR also acquired imagery of part of this test site in September, 1992. In November of 1990, the airborne SAR developed by the Chinese Academy of Sciences (CAS/SAR) covered this area for the purpose of Chinese spaceborne radar development. By studying and analyzing these SAR data we have achieved positive results in geoscientific applications.

Penetration. It is discovered that SIR-A has penetrated through the thin dry sand sheet at the Altengaobao area in Inner Mongolia. A triangular geologic body, which has a strong radar return, is clearly shown on the SIR-A image (Fig. 2a). The central part of the triangular geological body is totally covered by dry sand which is shown on the Landsat MSS image (Fig. 2b). Digging a shallow hole at the central part, the bedrock is exposed at about 1 meter of sand in the field verification. The geological map of this region shows that the upper part of the triangular body is Precambrian metamorphic rock, the lower part is comprised of Mesozoic granites, and the central part, covered by dry sand, is gneisses. The theoretical study indicates that the penetrating ability of radar should at least meet three conditions: 1) fine grain size; 2) less thickness; 3) extremely dry. The surface conditions of the test site are content with the former two conditions. The meteorological records of the test site show that the annual mean rainfall is less 150 mm, some places even less 10 mm, dryness is 4 - 12 (the dryness of adjacent desert is 7 - 12), and evapotranspiration is 31.5 times as rainfall, which means that the test site is content with the third condition.

Rock Type and Fault Recognition. The distribution and range of Caledonian plagioclase-granite at Wang Yang area in Gansu Province has been detected by using SIR-B data. Due to adverse natural circumstances and poor traffic, the test site is geologically under-studied, with only a few plagioclase granite bodies being displayed on the geological map. The large Bayinnorgong strike slip fault, 80 km long, was recognized on CAS/SAR and SIR-A images at the Bayinnorgon area of inner Mongolia, and the field work proved its existence. Several bunches of faults were interpreted from the SIR-A image of the Keping area in Xinjiang Province. The longest one is 50 km. Many secondary faults are well developed along the two sides of the major fault which cuts through all of the strata in the test site. The strata on the two sides are strongly distorted, deformed, and displaced, and the displacement is over 5 km.

Mineral Exploration. SAR is useful for detecting ore-controlling structures. A gold-bearing structure belt was directly discovered by the interpretation of SIR-A images in Honguyulin area. The belt is about 650 km long and composed of Sinian sandstone, limestone and quartz-diorite. Sampling along the belt, the chemical analysis results show that the gold tenor of most samples reaches 1 ppm and the highest sample is 7.94 ppm. The discovery of the gold-bearing structure belt has two leading factors: 1) The linear strong return anomaly. On one hand the strong return comes from the rough surface of the belt. On the other hand, it is caused by the high dielectric constant of altered rocks. The dielectric constant of the country rock is less than 7, but the mineralized rock is over 20. 2) The relevant analysis result. The gold-bearing structure belt is a fractured structure belt, distributing along and contacting with the granite body, which is an ideal location for metal mineral deposit.

Multi-parameter SAR Data Comparison. Jilantai area of Inner Mongolia is our spaceborne radar science test site. SIR-A, SIR-B, ALMAZ SAR and CAS/SAR data of the test site have been acquired so far (Fig. 1). Their parameters are as follows: Operation Bands: L, L, S and X; Spatial Resolution: 40mx40m, 32mx28m, 10-15m and 10mx10m; Look Angle: 47°, 26°, 45°, and 19°; Flight Direction: NW 80°, NE 20°, NW 20°, and NE 90°. All four SAR systems operate in HH polarization. With the diverse imaging parameters, they have different imaging effects.

The high-resolution imagery is more suitable for rock type discrimination. The detecting ability is better for desert areas when the radar illuminating direction is perpendicular to the slipface or sand dunes. The small depression angle will bring a lot of shadow and reduce the information.

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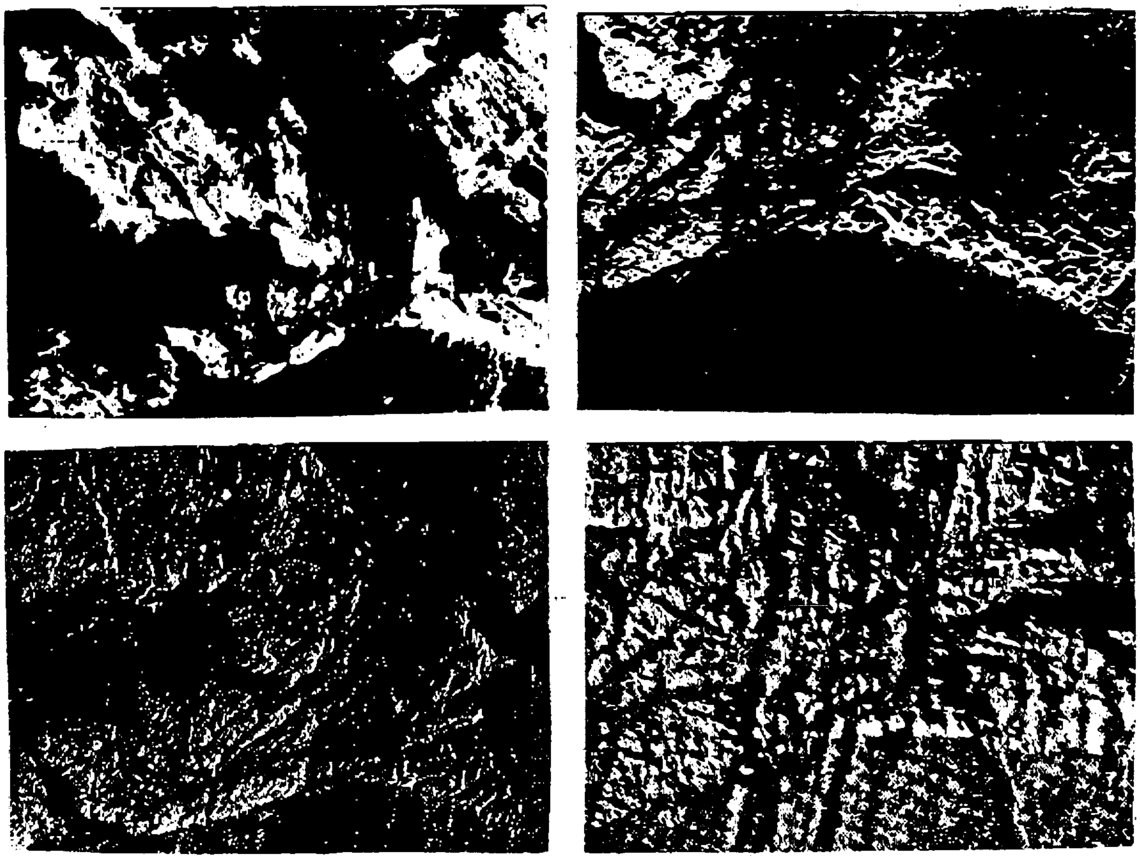

Figure 1. Jilantai test site of North China

SIR-A Image (upper left)
ALMAZ SAR Image (lower left)

SIR-B Image (upper right)
CAS/SAR Image (lower right)

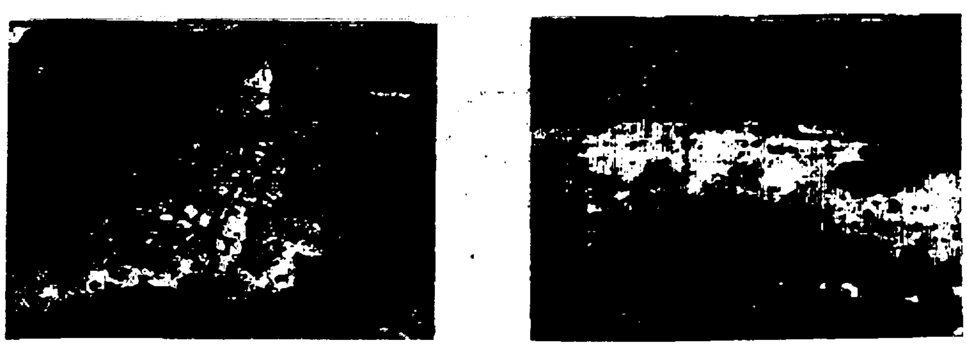

Figure 2. Altengaobao area of Inner Mongolia, North China

SIR-A image showing penetration phenomena (left).

Landsat MSS image (right).