# Estimation of the Simulated JERS－1 Data

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## 1. INTRODUCTION

OPS borne in JERS-1, which will be launched in 1992, is paid attention from the world, because it has four bands in short wave infrared region. The JERS-1 data were simulated by using the GER (GEOPHYSICAL ENVIRONMENTAL RESERCH COPR.) 64 channels airborne imaging spectrometer(AIS) data and evaluated as mineral exploration tool. The area studiede is Goldfield, Nevada of U.S.A.

## 2. DESCRIPTION OF THE TEST SITE

Goldfield is located in south central Nevada (Fig.1) and prospered in the gold rush the early years of this century. Gold deposits are centered at 3km NE of the town and are distributed in N-S direction. The ore bodies are irregular platy veins in the hydrothermally altered host rocks, which mainly consist of porphyritic rhyodacite. The altered zone is in a circular shape with a diameter of 4km (Fig.1). Over 130 tons of gold were mined from this area and a small mining activity persists to now.

## 3. THE AIRCRAFT DATA

GER AIS data consist of 63 channels data from visible through infrared region (Table 1). Scan parameters are in Table 2. The central wavelength of AIS channels and JERS-1 bands are in Table 3. Each pixel is rectangular, 20m in azimuth direction (NS), and 15m in range direction (EW). The imagery has been used without geometric correction. The original data is provided in digital form and is converted to radiance by the conversion functions supplied by GER.

## 4. JERS-1 DATA SIMULATION

Energy $P_i$ of electromagnetic waves which streamed into the JERS-1 band i detector can be written as follows:

$$P_i = k \int Tr(\lambda) \cdot Fi(\lambda) \cdot Ho(\lambda)\, d\lambda$$

where

- $k$ = constant value including f number of optical system
- $Tr(\lambda)$= transmission factor of the condenser system at wavelength $\lambda$
- $Fi(\lambda)$= spectral transmission factor of the spectral system of band i at wavelength $\lambda$
- $Ho(\lambda)$= radiance gotten by AIS at wavelength $\lambda$

Gaussian noise is added to this energy $P_i$ to correspond to S/N of band i, and $P_i$ is digitized into 6 bits. The data thus digitized was used as the simulated JERS-1 band i data for study. Flow chart of JERS-1 data simulation is shown in Figure 2. Main properties of JERS-1 OPS are shown in Table 4.

## 5. EVALUATION OF THE IMAGES MADE FROM SIMULATED JERS-1 DATA

The images made from simulated JERS-1 data were evaluated as a mineral exploration tool. Simulated images were black-and-white images, falsecolor images, ratio images and log residual images. Black-and-white images of band 1, 3, 6 and 8 are shown in Photo 1 to 4. These images are excellent qualities, and their brightness differences due to spectral characteristics are recognized very well. Simulated images were evaluated from the standpoint of mapping altered zones. We tried to extract and classify the altered zone by studying spectral absorption features from simulated OPS data. Spectral reflectance of important altered minerals and JERS-1 bands in region of 2.0$\mu$m to 2.5$\mu$m are shown in Figure 3.

From these simulated images and ground proof, several characteristics were recognized as follows:

① Falsecolor image (band 1,2,3=B,G,R)

The brightest zones correspond to mine dumps or dried waste pond. Goldfield town showed reddish color and it suggests the existance of vegetation.

② Falsecolor image (band 5,7,8=R,G,B)

Pinkish zones show the altered zone where alterection clay minerals are alunite, kaolinite, montmorillonite and sericite. These minerals have typical spectrum absorption near 2.2$\mu$m, so the brightness of band 7 is relatively darkened and the altered zone became pink. However, the color difference among these minerals could not be recognized.

③ Ratio image (band5/band7,band6/band7,band7/band8=B,R,G)

Violet zones correspond to the altered zone as the pinkish colored zones of the preceding image.

④ Log Residual image (band 1,2,3=B,G,R)

The log residual technique is the method to remove effects of atmospheric scattering and absorption, and brightness difference due to slope orientation. This technique is effective to be applied in the area with many kinds of clay minerals and sparsely existing vegetation like Goldfield area because the minute change in reflectance is emphasized.

Image ④ has more variety of colors than image ①. Greenish zone corresponds to the iron oxide zone. This greenish zone coincids with the area extracted as the hematic zone by Chebyshev waveform analysis of GER that used 63 channels data. This fact shows the validity of JERS-1 data.

⑤ Log Residual image (band 5,7,8=R,G,B)

In image ⑤, the altered zone is in dark reddish, reddish and pinkish zones. The change in color suggests the difference of minerals.

## 6. CONCLUSION

The resurts of this JERS-1 data simulation over Goldfield area are as follows:

① The area covered with vegetation can be extracted by using falsecolor images, ratio images and log residual images.

② The altered zone where alterection clay minerals are montmorillonite, alunite, sericite, kaolinite, etc. can be

extracted by using falsecolor images and ratio images.
③ The iron oxide zone can be extracted by using log residual images.
④ Clay minerals in the altered zone could be calssified in log residual images.
⑤ We could not evaluate the possibility for extraction of carbonate rocks like limestone that have spectrum absorption in JERS-1 band 8 bacause of no carbonate rock in the study area.

It is recognized that OPS data of JERS-1 is useful for mineral exploration. As a next step, we will try to differentiate mineral components in rock formations by JERS-1 OPS data.

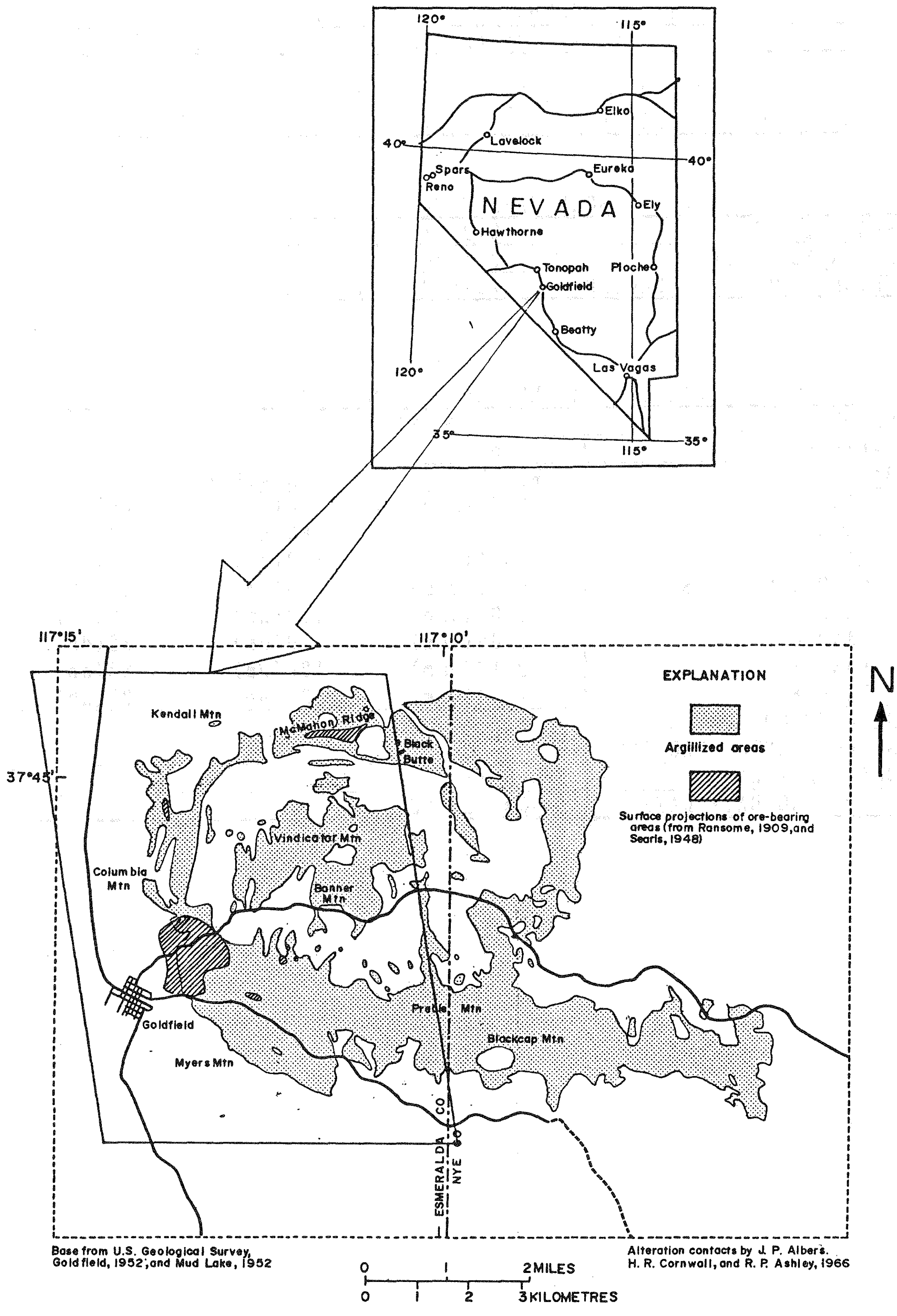


Fig.1 MAP OF THE TEST SITE

Table 1 FORMATION OF AIS DATA

| | VISIBLE/NEAR INFRARED | | INFRARED |
|---|---|---|---|
| CHANNEL | 1 ~ 24 | 25 ~ 31 | 32 ~ 63 |
| BAND (nm) | 420.9 ~ 984.5 | 1,020 ~ 1,860 | 1,978 ~ 2,5036 |
| BAND WIDTH | 25.4nm | 120nm | 16.5nm |

Table 2 SCAN PARAMETERS

| | |
|---|---|
| SWATH WIDTH | 512 pixels |
| SCANNING ANGLE | 3 mrad. |
| HEIGHT ABOVE THE GROUND | 20,000 feet |

Table 4 PARAMETERS OF OPS OF JERS-1

| | | | |
|---|---|---|---|
| RESOLUTION | 18.3m × 24.2m | | |
| SWATH WIDTH | 75km | | |
| BAND | WAVELENGTH | BAND WIDTH | S/N |
| BAND 1 | 0.56(μm) | 80(nm) | 46(db) |
| BAND 2 | 0.66(μm) | 60(nm) | 46(db) |
| BAND 3 | 0.81(μm) | 100(nm) | 46(db) |
| BAND 4(STEREOSCOPE) | 0.81(μm) | 100(nm) | 46(db) |
| BAND 5 | 1.65(μm) | 110(nm) | 42(db) |
| BAND 6 | 2.06(μm) | 110(nm) | 32(db) |
| BAND 7 | 2.19(μm) | 120(nm) | 33(db) |
| BAND 8 | 2.34(μm) | 130(nm) | 27(db) |
| BASE HEIGHT RATIO IN STEREOSCOPIC IMAGEING | 0.3 | | |
| QUANTIZATION | 6 BITS | | |
| RECORDING DATA RATE | 30Mbps×2CH. | | |

TABLE 3 THE CENTRAL WAVELENGTH OF AIS CHANNELS AND JERS-1 BANDS

| CHANNEL | WAVELENGTH ($\mu m$) | BAND |
|---|---|---|
| 1 | 0.4336 | |
| 2 | 0.4570 | |
| 3 | 0.4804 | |
| 4 | 0.5038 | BAND 1 |
| 5 | 0.5272 | BAND 1 |
| 6 | 0.5506 | BAND 1 |
| 7 | 0.5740 | BAND 1 |
| 8 | 0.5974 | BAND 1 |
| 9 | 0.6208 | BAND 1, BAND 2 |
| 10 | 0.6442 | BAND 2 |
| 11 | 0.6676 | BAND 2 |
| 12 | 0.6910 | BAND 2 |
| 13 | 0.7144 | BAND 2 |
| 14 | 0.7378 | BAND 3 |
| 15 | 0.7612 | BAND 3 |
| 16 | 0.7846 | BAND 3 |
| 17 | 0.8080 | BAND 3 |
| 18 | 0.8314 | BAND 3 |
| 19 | 0.8548 | BAND 3 |
| 20 | 0.8782 | BAND 3 |
| 21 | 0.9016 | |
| 22 | 0.9250 | |
| 23 | 0.9484 | |
| 24 | 0.9718 | |
| 25 | 1.0800 | |
| 26 | 1.2000 | |
| 27 | 1.3200 | |
| 28 | 1.4400 | |
| 29 | 1.5600 | BAND 5 |
| 30 | 1.6800 | BAND 5 |
| 31 | 1.8000 | |
| 32 | 1.9860 | BAND 6 |
| 33 | 2.0024 | BAND 6 |
| 34 | 2.0189 | BAND 6 |
| 35 | 2.0353 | BAND 6 |
| 36 | 2.0517 | BAND 6 |
| 37 | 2.0682 | BAND 6 |
| 38 | 2.0846 | BAND 6 |
| 39 | 2.1010 | BAND 6 |
| 40 | 2.1174 | BAND 6, BAND 7 |
| 41 | 2.1339 | BAND 6, BAND 7 |
| 42 | 2.1503 | BAND 7 |
| 43 | 2.1667 | BAND 7 |
| 44 | 2.1832 | BAND 7 |
| 45 | 2.1996 | BAND 7 |
| 46 | 2.2160 | BAND 7 |
| 47 | 2.2325 | BAND 7 |
| 48 | 2.2489 | BAND 7, BAND 8 |
| 49 | 2.2653 | BAND 7, BAND 8 |
| 50 | 2.2817 | BAND 8 |
| 51 | 2.2982 | BAND 8 |
| 52 | 2.3146 | BAND 8 |
| 53 | 2.3310 | BAND 8 |
| 54 | 2.3475 | BAND 8 |
| 55 | 2.3639 | BAND 8 |
| 56 | 2.3803 | BAND 8 |
| 57 | 2.3968 | BAND 8 |
| 58 | 2.4132 | BAND 8 |
| 59 | 2.4296 | BAND 8 |
| 60 | 2.4460 | |
| 61 | 2.4625 | |
| 62 | 2.4789 | |
| 63 | 2.4953 | |

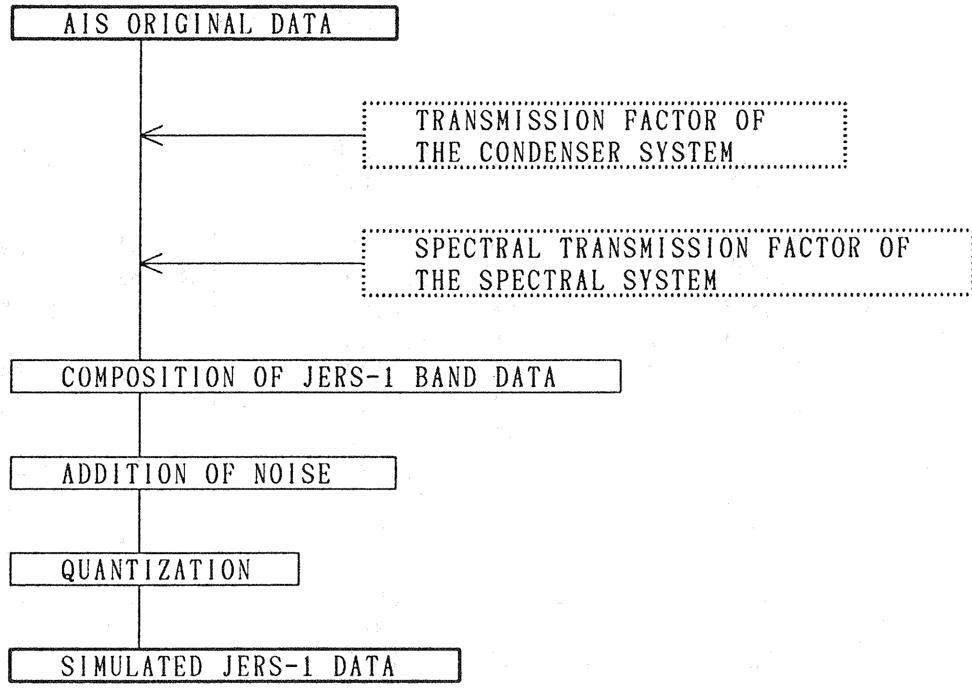


Fig.2 FLOW CHART OF JERS-1 DATA SIMULATION

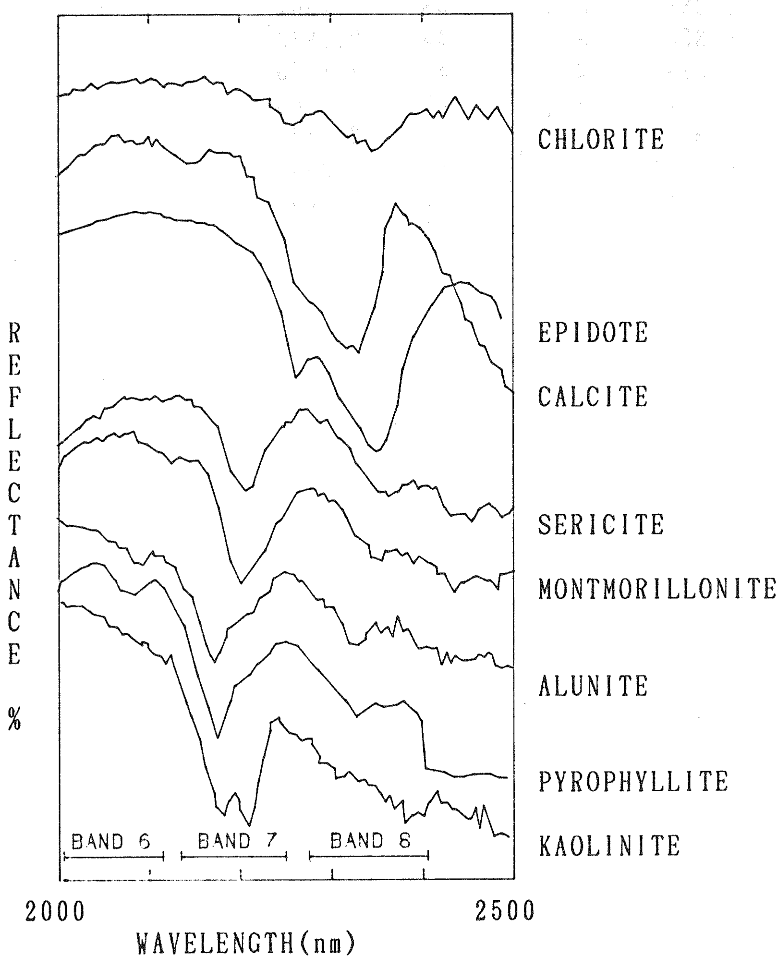


Fig.3 SPECTRAL REFLECTION FACTOR OF ALTERED MINERALS

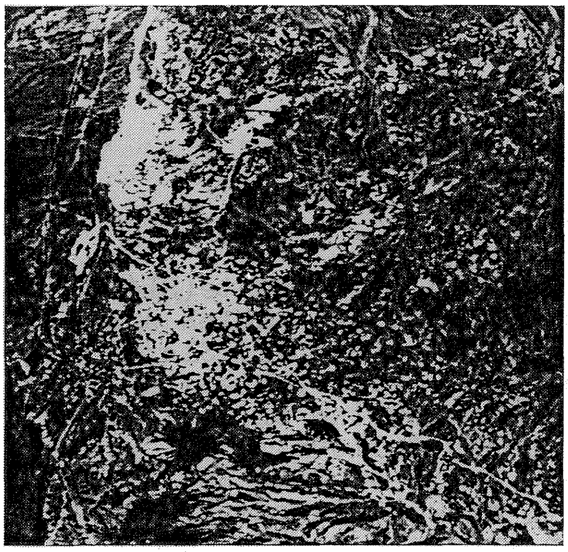

PHOTO 1 SIMULATED IMAGE
(BAND 1)

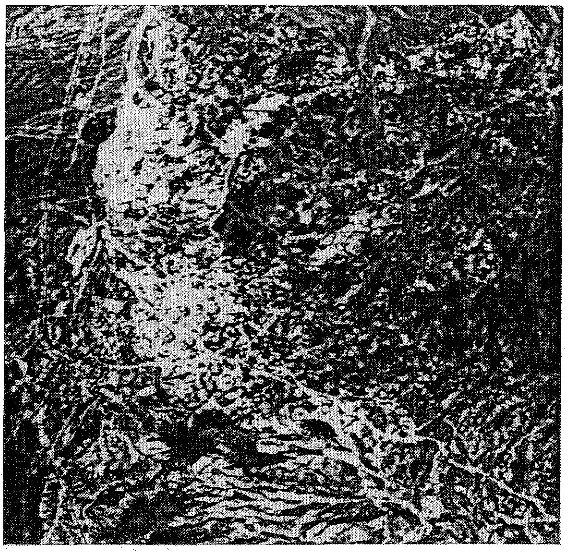

PHOTO 2 SIMULATED IMAGE
(BAND 3)

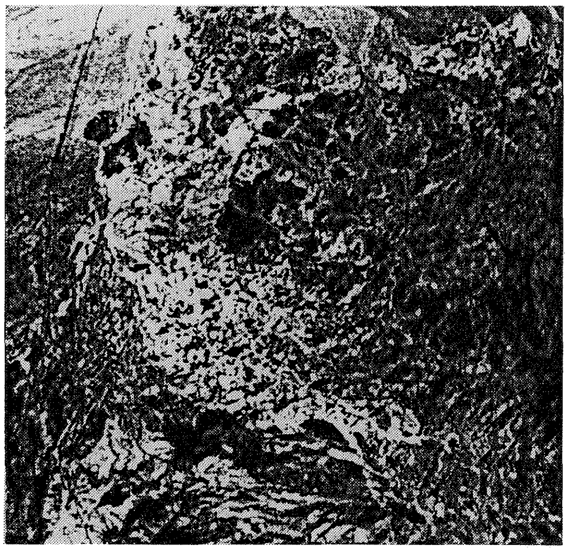

PHOTO 3 SIMULATED IMAGE
(BAND 6)

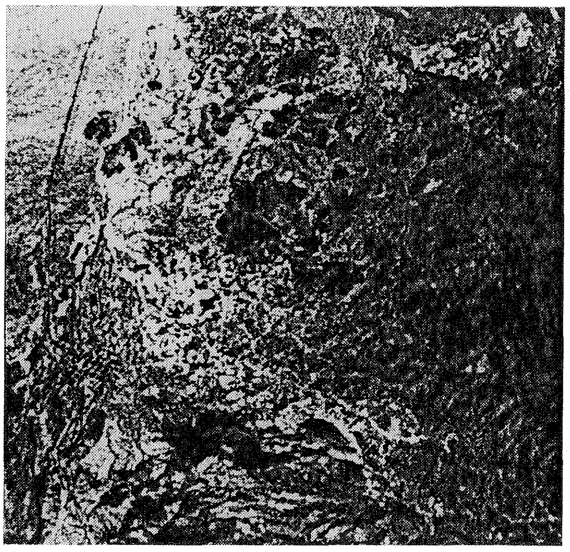

PHOTO 4 SIMULATED IMAGE
(BAND 8)