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SOYUZ 22: NEW CONTRIBUTION TO EARTH STUDY FROM SPACE

by

L. A. Vedeshin, V. V. Ivanov & Ye. D. Sulidi-Kondrat'yev

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"SOYUZ-22": NEW CONTRIBUTION TO EARTH STUDY FROM SPACE

L. A. Vedeshin
"Interkosmos" Council, Academy of Sciences USSR

The basic goal of space flight "Soyuz-22", which took place /20.
in September 1976 within the framework of a cooperative program between socialist countries for the study and use of outer space for peaceful purposes, was the development and improvement of scientific-technical methods and means for researching the Earth's natural resources from outer space to aid the economy. The new multispectral space camera MKF-6, developed by specialists from the Space Research Institute of the Academy of Sciences USSR and from the "Karl Zeiss Jena" factory, successfully underwent experimentation on board "Soyuz-22". This unique device permitted cosmonauts V.F. Bykovskiy and V.V. Aksenov to photograph selected areas of the USSR and the German Democratic Republic in four visible and two infrared regions of the sepctrum (this is where the experiment gets its name - "Raduga" (Rainbow). Approximately 2500 pictures in each spectral range were obtained. MKF-6 simultaneously photographs areas in six regions of the spectrum (in the 480-840 NM range) and registers both the natural electromagnetic radiation of the surface objects and the solar radiation reflected by them. The device yields a high information content in the photographs with a resolution of 20 meters and encompasses large areas in the pictures (a frame covers on the average 17,000 km^2).

Initially, the designers were asked to develop specifically a six-spectral camera; in the laboratories of the Space Research Institute of the Academy of Sciences USSR the spectral characteristics of approximately 2,000 surface devices were analyzed, their reflective characteristics were examined, their particularities and conditions of discrimination were distinguished. The point is that in different zones of the spectrum, one or another earth object, one or another natural phenomenon is better visible. The optical range has the best information content - the widest range in the radiation spectrum. It is highly sensitive to such physio-chemical and biological parameters of earth formations as the chlorophyll content in the green mass, the phytoplankton content in reservoirs, the salinity of the water and its pollution, the composition and humidity of the soil, etc. Thermal infrared radiation yields information on the temperature changes of natural formations, aids in locating sources of geothermal waters, plutonic fractures in the earth's core, areas of vegetation that are afflicted with some disease. Radio waves penetrate huge thicknesses of the earth's covers, accurately reflect the geometrical characteristics of the surface, etc. But, the most complete information is derived from a combination of the data registered in different ranges.

We already conducted a multizonal photographing in our country from on board "Soyuz-12" and "Soyuz-13", later this same method was used during the second expedition to the orbiting space station "Salyut-4". Cosmonauts P. I. Klimuk and V. I. Sevastyanov photographed from a height of 340 kilometers with a block of four cameras in narrow spectral intervals of the optical range and the near infrared region.

The photographing in each of the selected sections of the spectrum yielded unique information about natural objects, and the 500-600 NM zone contained the most information on the shoals and river drift; the 600-700 NM zone contained the most information on objects of limited area, because it has the best spatial resolutions; the 700-840 NM zone most zccurately reflected the geological structure of the territory.

The photographs from "Soyuz-22" are currently being analyzed in the Space Research Institute of the Academy of Sciences USSR. To interpret the photographs we are using a multispectral MSP-4 projector developed by specialists from the USSR and the German Democratic Respublic, which permits synthesized color images to be obtained magnified five times from four black and white pictures made in the differential spectral zones. Each spectral range is given its own arbitrary color; by varying the color mosaic, isolation of the needed objects on the image is achieved.

V. V. Ivanov, Ye. D. Sulidi-Kondratyev
Candidates of Geological-Mineralogical Sciences
Sceintific Research Laboratory of Geology of Foreign Countries,
Ministry of Geology USSR

/21.

Photography onboard "Soyuz-22" was conducted at the request of dozens of scientific and industrial organizations in the country. Geologists and geophysicists, oceanologists and land reclaimers, agricultural and fishing specialists, glaciologists, meteorologists and foresters, have all obtained a new effective means for studying

natural resources, locating regions prospective for searching for mineral and ore deposits, determining water reserves in glaciers and seasonal snow covers, precise researching the earth's atmosphere and cloud formations, river flows and ice conditions, and studying the interaction of cold and warm currents in the ocean, uplifts of subsurface waters, locating concentrations of commercial fish, evaluating soil and sowing conditions, plotting the distribution of different types of rocks, trees, etc.

Space photography has significant meaning for geological research in locating mineral deposits. According to specialists' evaluations, geologists utilize more than half of the space information. As studies completed in different regions of the country have shown, space photographs were very effective in studying fracture tectonics, in determining the plutonic structure of platform areas, in locating different concentric-ring structures. The results of such research aided in conducting a metallogenic analysis of vast territories, were necessary in studying geological-engineering conditions, and in particular, seismic-tectonic conditions.

On the first page of the cover there is part of a space photograph of Pamiro-Alai. It clearly depicts the joinig area of the tectonic areas of Pamir and southern Tyan-Shan, which has been attracting the attention of specialists for a long time. In the center of the picture the Alai valley is visible; to the north and south of it there are large morpho-strucutral elements of the Alai and Zaalai ridges. We see sharp, straight lines corresponding to the large fissures in the earth's crust. The picture aids in defining more accurately the pattern of the fissures, and aids in analyzing the complex geodynamic

conditions of this region.

A comparison of pictures taken in different spectral zones helps to interpret more substantially geological objects. One of the advantages of space photographs pver aerial photographs is their large field of vision: the geologist does not see separate elements of one or another structure, but sees the entire picture on them.

In this picture we see the relation between the fractures and the folded deformations, distribution areas of cretaceous red rocks, strata of carbonates and metamorphic slates, intrusive massifs are clearly delineated. Different complexes of young Quaternary deposits, particularly ancient moraines, are well contoured in the Alai valley.

In the picture of the Lake Baikal region there is a well depicted giant tectonic fissue in the earth's crust restricted by rift faults. Among them is the Primorskiy fault, not especially clearly isolated, which extends in the form of a gently sloping arc for almost 250 kilometers: along this young fault there are modern movements accompanied by seismic dislocations. An entire system of parallel fractures is noticeable in the range of the Primorskiy ridge. The Proval bay which emerged in the last epoch is particularly interesting. It emerged because of earthquakes and adjoins the Selenga Delta. In the mouth of this river we can accurately follow areas of its drift. To the north of Baikal in the area of the Primorskiy ridge large expanses of larch and larch-Pine forests are clearly depicted, and strip felling areas in the form of parallel fields are visible.

Studying the earth from space has just begun to expand and the

development of methods of interpreting the obtained data is acquiring special value. In our country there are approximately 50 scientific test sites. During the "Soyuz-22" flight, research on these test sites was simultaneously conducted on three levels: space, aerial (using aerial photographs in the same ranges) and surface. A comparison of the results of the studies conducted by ground parties with the information from space aids in a detailed study of the spectral characteristics of different land formations and natural phenomena, it helps to systematize such spectral signs, which subsequently will make it possible to automate their findings and precise analysis using data from the space photographs.

The advantages of space photography for scientific and economic needs are obvious. From an economic point of view, a five-minute survey of territory from "Soyuz-22" is equal to two years work from an airplane using special cameras and to 80 years of work for a geodetic surface party.

Pictures* of the northern peaks of Tyan-Shan taken by Cosmonauts /23.
P. I. Klimuk and V. I. Sevastyanov from orbiting space station "Salyut-4". The photography took place simultaneously in three spectral zones. Different colored pictures are obtained by optical synthesis on three initial black and white pictures, and the illustrations in the same zones are tainted in different colors. On the left, above, an illustration in the zone 500-600 NM is green, 600-700 NM is red, 700-800 NM is blue. The reddish brown tones correspond to underbrush growth and also to cultivated land with crops. On the lower left, illustration in the 500-600 NM zone is red, 600-700 NM zone is blue, 700-840 NM is green. We see differences in the landscape depending on the altitude of the site. In this variation of the synthesis the mountainous plant growth shows very well: each rose, red and brown shade corresponds to its different characteristics. On the upper right, the illustrations in the 500-600 NM zone is blue, 600-700 NM is green, and the 700-840 NM is red. The soil in inter-mountainous valleys is clearly depicted. On the lower right there is a color picture of the same region.

Arbitrary color picture. Optical-electronic quantization from definite levels of optical densities, and color coding of these levels are conducted to obtain it. This is done to single out specific peculiarities of objects. The colors stress the boundaries of different natural formations. [Fragments from "Multizonal Photoinformation Samples Obtained from the Long-Term Orbiting Space Station Salyut-4" GUGK, 1976].

*Translator's Note: Because of difficulties of reproductions, the pictures are not reproduced in this translation.