focussed on the problem of developing small-scale thematic maps. The preparation of small-scale thematic maps is our most difficult resource task; it takes a great deal of time to collect and reduce data from many places in a large region in order to produce a map giving a broad overview. These small-scale maps cannot, with present methods, effectively portray features of a dynamic quality.

The sensors that have been selected for the initial satellite will provide information on the configuration of terrain, including underwater features, and on the distribution of water as free water and as moisture. These same sensors will also provide information on the distribution of vegetation, the vigor of vegetation, the distribution of alien fluids within water, and the coloration of rocks and soils. We believe these observations are the most meaningful ones that can be made to serve the needs of the largest number of disciplines.

These sensors have a common geometry so that the results of the observations may easily be compared. The selected sensors and orbital parameters produce images that contain the least possible number of variables so that the data may be usefully applied to resource purposes by scientists having a minimum of training and experience. Also, the data are amenable to automatic analysis.

We are planning on a long-life vehicle so that we may determine the rates at which land use and other changes are taking place and so that we may obtain resource information from seasonal variations in the appearance or character of the terrain.

One of the initial objectives of the program is to produce a photo-image map of the world. The desirability and practicality of undertaking such a task is demonstrated by the mosaic of space photographs of Peru, recently compiled by the Geological Survey. Secretary Udall, in describing this mosaic before the recent meeting of the American Society of Oceanography, said "This mosaic covers roughly a third of a million square miles. In just one pass, the Gemini astronauts photographed almost 80% of Peru; it took just three minutes. The scientists who have seen this mosaic consider it to be superior to any available map of the region, in terms of information conveyed. One can see the gross patterns of land use, distribution of snow, the levels of the lakes, geologic features of possible economic significance—all at a single glance . . . the value of such mosaics in planning the development and use of lands is so great that I believe we ought to do more of this kind of work." Because of the inherent orthographic quality of space photography, this mosaic is in essence a map; the cost of compiling this mosaic was approximately one-tenth of one cent per square mile.

In addition to applying available space data to our current resources problems, and looking ahead toward the development of an initial program of space flight for resource purposes, we are participating in NASA's continuing program of remote sensor research. This research has the dual purpose of (1) developing new and increasingly sophisticated instruments for resource observation purposes and (2) evaluating instruments that have been developed elsewhere in the Government (principally in the military establishment) with respect to their potential use for resource purposes.

The Geological Survey is actively investigating the design and development of aircraft and spacecraft instruments to detect and measure reflected ultraviolet energy, ultraviolet stimulated luminescence, emitted infrared radiation, reflected radar energy, and the magnetic field of the earth. We are also working cooperatively with the Department of Commerce in defining camera systems which, when flown in orbit, will make possible timely revision of our national topographic maps. A recently completed cost-benefit study suggests an annual benefit of $155 million per year from domestic map revision alone.

*What are the potential benefits of our continuing research?*

## They Can Help in Our Studies of Geologic Hazards and Our Search for Sources of Geothermal Energy

Figure 26 compares an aerial photograph and an infrared image of Mt. Rainier, Washington. Bright areas on the infrared image are areas of abnormal warmth. The presence of thermal anomalies suggests that Mr. Rainier may still be a hazard; however, these anomalies also suggest that the mountain contains sources of thermal energy that might be harnessed for the benefit of man. The Geological Survey, the Government of Iceland, and the Air Force recently completed a cooperative infrared survey of known geothermal power sources in Iceland. These surveys demonstrated that modern infrared systems could be used to map potential geothermal power sources; all known thermal anomalies were successfully imaged, and a few previously unknown anomalies were found.