*Remote Sensing Brief*

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# The Side-Looking Airborne Radar Program of the U.S. Geological Survey

SLAR images are presently being analyzed by the USGS to support mapping of geologic structures in the folded and thrust-faulted Appalachian Mountains, appraisal of geologic hazards, and monitoring of foliage cover for use in geologic research.

In 1980, the U.S. Geological Survey (USGS) began a systematic side-looking airborne radar (SLAR) program. SLAR imagery of more than 390,000 km$^2$ of the conterminous United States and Alaska has been acquired during the past three years. SLAR data for an additional 609,000 km$^2$, including much of the Appalachian region of the eastern United States, will be acquired and entered in the public domain through the USGS' Earth Resources Observation Systems (EROS) Data Center during 1984. The multidisciplinary program has involved governmental (USGS, State), academic, and industrial scientists, who addressed site selection and participated in more than 50 research and data-analysis projects concerning SLAR applications to geology, cartography, and hydrology; 13 of these projects are described by Moore and Sheehan (1981).

The illustration on the cover of this issue of *Photogrammetric Engineering and Remote Sensing* is a 1:250,000-scale synthetic-aperture SLAR image combined photographically with part of the Geologic Map of West Virginia (Cardwell *et al.*, 1968), and was produced by the author and Howard A. Pohn. The color-coded image portrays the stratigraphy of the region, which includes sedimentary rocks of Silurian (red), Devonian (green, pink, and blue), and Mississippian (orange) age and Quaternary (yellow) alluvial deposits (Table 1). The SLAR imagery was acquired 13 September 1982, by Aero Service*, Houston, Texas, under a contract with the USGS, using the Goodyear Electronic Mapping System (GEMS) 101 radar system. The data were acquired from an altitude of 12 km in a north-to-south flight direction (looking west), with an X-band (3.1-cm) wavelength and with horizontal-horizontal (HH) polarization. The data were recorded from 37-km-wide

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Table 1. Explanation to cover illustration

| Symbol | Age | Geologic Unit | Lithology |
|---|---|---|---|
| Qal | Quaternary | alluvium | sand, gravel, clay |
| Mp | Mississippian | Pocono | sandstone (ss) |
| Dhs | Devonian | Hampshire | shale (sh), ss, siltstone (slt) |
| Dch | Devonian | Chemung | ss, sh, slt |
| Db | Devonian | Brallier | sh, slt, ss |
| Dmn | Devonian | Onondaga | sh, limestone (ls), chert |
| Do | Devonian | Oriskany | ss |
| Dhl | Devonian | Helderberg | ls, ss, sh |
| Smc | Silurian | McKenzie | sh, ss, slt |

⩘ Anticline
✳ Syncline

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TABLE 2. PAST AND PLANNED ACQUISITION BY THE U.S. GEOLOGICAL SURVEY OF SLAR (SIDE-LOOKING AIRBORNE RADAR) DATA

| Project Area | No. of 1° × 2° Quadrangles Covered or Area Covered | Look Direction | Approximate Depression Angle Range (Near to Far) |
|---|---|---|---|
| | 1980–81 | | |
| Alaskan Peninsula | 13 | Varies | Varies |
| Northern Alaska (Brooks Range, North Slope) | 8 | North and South | 21°–6° |
| | 1982 | | |
| Aleutian Islands | 11 | Varies | 34°–17° |
| Tonopah, Nevada | 1 | North 56° West | 28°–9° |
| | 0.3 | South 10° West | |
| Central Appalachian Mountains | 5 | Varies | 33°–10° |
| New Jersey | 2,400 km$^2$ | Northeast and Northwest | 15°–7° |
| New England | 3.3 | West | 33°–10° |
| | 1984 PLANNED | | |
| Southern Appalachian Mountains | 19 | Varies | 38°–9° |
| Appalachian Piedmont | 3 | West | 38°–9° |
| Adirondack dome | 3 | West | 38°–9° |
| New England coast | 11 | West | 38°–9° |

swaths in both near- and far-range presentation. The depression angle ranged from approximately 33° in near range to approximately 10° in far range. The spatial resolution of the SLAR image data is 10 m along flight-line azimuth and 12 m down range. Film strips for each swath were generated from holographic film by use of a laser optical correlator. SLAR images are presently being analyzed by the USGS to

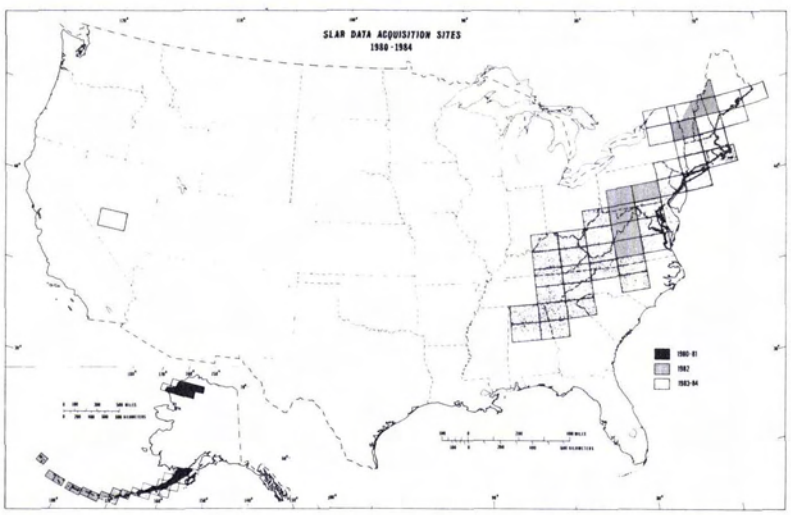


FIG. 1. Areas where SLAR data were acquired in 1980–1981 and 1982 and where acquisition of SLAR data is planned during 1984.

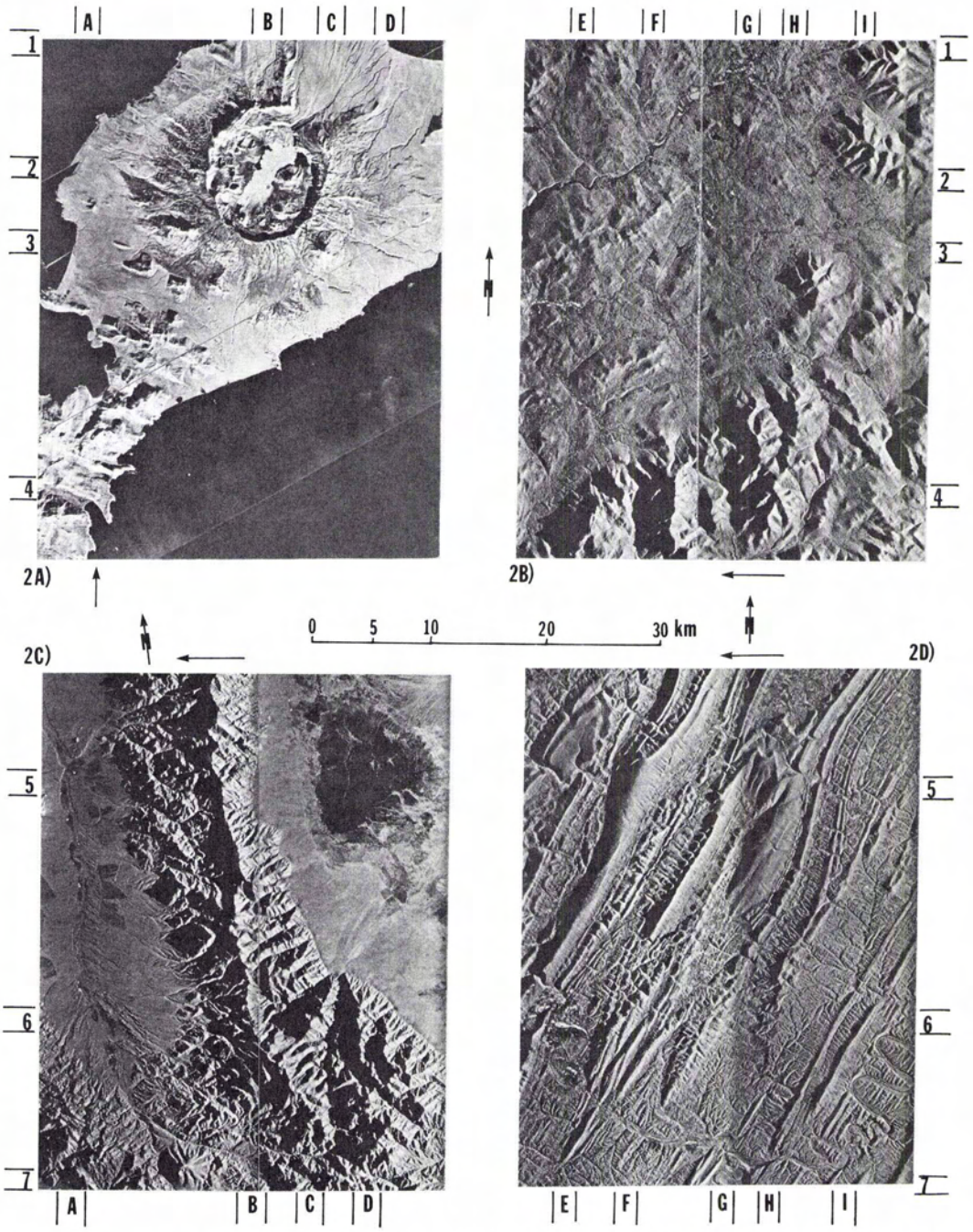


FIG. 2. Examples of SLAR imagery of the United States acquired in 1982 by the U.S. Geological Survey. *A*, Umnak Island, Alaska. *B*, White Mountains, Vermont and New Hampshire. *C*, Toiyabe Range, Nevada. *D*, Valley and Ridge province of the Appalachian region, Maryland and West Virginia. Numbers and letters in margin are referenced in the text.

support mapping of geologic structures in the folded and thrust-faulted Appalachian Mountains, appraisal of geologic hazards, and monitoring of foliage cover for use in geologic research.

Areas where SLAR data were acquired in 1980-81 and 1982 and where acquisition of SLAR data is planned during 1984 are listed in Table 2 and shown in Figure 1. Technical parameters (collection system, look angle, and depression angle) for these acquisition areas were tailored to optimize the potential use of these data. SLAR image data acquired from 1980 to 1982 are available to the public through the USGS' EROS Data Center, User Services, Sioux Falls, South Dakota 57198, (605) 594-6151. Image strips at the scale of 1:400,000 are available as prints or film transparencies. Film and contact prints of SLAR imagery at 1:250,000 scale, mosaicked to conform with 1° by 2° quadrangle maps of the United States are available. SLAR fact sheet, order form, and microfiche depicting flight-line coverage are also available.

Figures 2*A-D* are examples of SLAR imagery acquired during the 1982 flight program. The 1:400,000-scale image strips (prints) of far-range imagery were manually joined by the author to produce uncontrolled composites. Radar-look direction is labeled by the small arrow. Symbols in parentheses below refer to grids in Figure 2.

Figure 2*A* depicts Umnak Island of the Aleutian Islands, Alaska. Radial drainage extends from the rim of the Quaternary Okmok caldera (B2) and Tulik volcano (C3) to the Bering Sea (A1) and Pacific Ocean (D4). As recently as October 1983, volcanic plumes vented from the resurgent domes inside the caldera. Research in the use of SLAR imagery of the Aleutians for cartographically accurate map production is presently being conducted by the USGS. The image mosaic, centered at 53°15′ north latitude, 168°00′ west longitude, is composed of images acquired along flight lines 11, 21, and 33 in August-September 1982.

Figure 2*B* depicts the White Mountain batholith (H4) and associated stocks (I1) and domes (I3) of New Hampshire which are composed of plutonic rocks of disputed age. The Bronson Hill anticline (E4 to I1) trends northeast across the area shown. The Connecticut River (F2), which flows from the north past Lancaster (G1), marks the boundary between Vermont (F1) and New Hampshire (G2). Geologists currently are using SLAR imagery to support mapping of geologic hazards (landslides) and mineral resources in this region. The image mosaic, centered at 44°15′ north latitude, 71°35′ west longitude, is composed of images acquired along flight lines 140, 150, and 160 in September 1982.

Figure 2*C* depicts the Toiyabe Range (B6), approximately 97 km north of Tonopah, Nevada, which is composed of Cambrian to Permian sedimentary rocks and Tertiary silicic tuffs. The Toiyabe Range, part of the block-faulted Basin and Range province, is bounded to the east by a Quaternary alkali playa (D5), which acts as a specular reflector to the radar energy and appears black. To the west is the Reese River valley (A5), which is composed of Quaternary alluvium. Geologists are currently using SLAR imagery to support geologic mapping of the region. The image mosaic, centered on 39°00′ north latitude, 117°15′ west longitude, is composed of images acquired along flight lines 130 and 140 in September-October 1982.

Figure 2*D* depicts the folded and thrust-faulted Valley and Ridge province of the Appalachian Mountains, composed of Ordovician through Pennsylvanian sedimentary rocks. The Wills Mountain anticline (F5), capped by Silurian orthoquartzite and breached to the north, trends northeast from Cumberland, Maryland (E6). Less competent rock, specifically Devonian sandstone and shale, erodes more readily and forms valleys (I6). The Potomac River (H7) flows east past Cumberland, Maryland, where it forms the Maryland-West Virginia border. Geologists are currently using the Appalachian SLAR imagery to map geologic structures and hazards. The image mosaic, centered on 39°45′ north latitude, 78°45′ west longitude, consists of images acquired along flight lines 100 and 110 in September 1982.

## References

Cardwell, D. H., R. B., Erwin and H. P., Woodward (compilers), 1968. *Geologic Map of West Virginia:* Morgantown, W. Va., West Virginia Geological and Economic Survey, 2 sheets, scale 1:250,000.

Moore, G. K., and C. A., Sheehan (compilers), 1981. *Evaluation of radar imagery for geologic and cartographic applications:* U.S. Geological Survey Open-File Report 81-1358, 37 p.

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