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SATELLITE GEOLOGICAL AND GEOPHYSICAL REMOTE SENSING OF ICELAND

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1 July 1973

Type I Progress Report for Period 1 May 1973 - 30 June 1973

Prepared for:

Goddard Space Flight Center
Greenbelt, Maryland 20771

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Type I Progress Report
ERTS-1

a. Title: Geological and Geophysical Remote Sensing of Iceland

ERTS-A Proposal No.: SR 9651

b. GSFC ID No. of P.I.: IN 079

c. Statement and explanation of any problems that are impeding the progress of the investigation:

Even though the video tape recorder on ERTS-1 is pretty much out of commission, it has been learned that approximately 30% of the capability (11 min. out of 30 min.) still exists. For that reason I have addressed a letter to Mr. John Boeckel, dated 11 June 1973, which requested that strong consideration be given for additional coverage of Iceland, particularly along the track of orbit 77 (and for orbits 63, 49, and 35, in descending order of priority), for the following reasons:

1. Acquisition of ERTS-1 imagery of Heimaey, the island on which the catastrophic volcanic eruption of Kirkjufell Volcano occurred. ERTS-1 imagery exists of the island prior to the eruption, during the eruption, but not after the eruption had subsided. Post-eruption ERTS-1 imagery of the island of Heimaey is mandatory for the measurement of the increase in size of the island because of lava flows. The eruption plume and steam rising from contact of lava with the sea obscured the new land area on ERTS-1 imagery acquired during the eruption.

2. Nearly all of available ERTS-1 imagery of Iceland is from the fall or winter period. The rangeland (grasslands) and forests experiment requires imagery during the growing season. ERTS-1 imagery during the summer months is needed.

3. The persistence of winter snow into the summer months, and the mapping of glacier margins during minimum snowcover (August) also requires summer coverage of Iceland.

d. Discussion of the accomplishments during the reporting period and those planned for the next reporting period:

1. An abstract of a paper to be given at the American Society of Photogrammetry Symposium on "Management and Utilization of Remote Sensing Data" which will be held in Sioux Falls, South Dakota, on 29 October - 2 November 1973, has been accepted for presentation. The title of the paper is, "Iceland: Preliminary Results of Geologic and Hydrologic Studies with ERTS-1 Imagery."

2. A paper entitled, "The Volcanic Eruption on Heimaey, Vestmann Islands, Iceland: General Geologic Aspects and Control of Lava Flows," and co-authored by James G. Moore (U. S. Geological Survey) has been prepared and will be submitted shortly to GEOTIMES.

3. Two papers, one on structural implications of the ERTS-1 image of Vatnajökull, the other on the volcanic geomorphology and glaciological implications of the ERTS-1 image of Vatnajökull are in preparation. They will be completed during the next reporting period and submitted to Jökull for publication.

4. As a result of the preparation of the ERTS-B Proposal, "Jökulhlaups from Grímsvötn, Vatnajökull, Iceland: Method of Prediction with the ERTS-B Data Collection System" (21790), I will complete, during the next reporting period, a paper entitled, "Icelandic Jökulhlaups: A Review." The paper will be submitted to Geological Society of America Bulletin for publication consideration.

5. All of the ERTS-1 imagery of Iceland thus far received has been catalogued. One set is being analyzed by me; the other set has been archived at Landmaelingar Íslands (Icelandic Surveying Department), where it is available to my Icelandic coinvestigators and to the general public. All usable (significant areas which are cloud-free) ERTS-1 imagery has been studied on a preliminary basis. Of the 80 ERTS-1 images acquired of Iceland (41 during 1972 before it became too dark, 39 during 1973 when it became light enough) 53 images have at least some value to one or more of the 10 proposed experiments. Only a handful of the images, however, (12 out of 80), have 50% or less cloud cover.

6. One-half of the next reporting period (the month of July) will be devoted to field work in Iceland. Sites will be visited on the ground and by aerial reconnaissance. Specific field trips will be made to Heimaey (site of the catastrophic volcanic eruption), the southern margin of the Vatnajökull glacier, and several geothermal areas. Both hand-held (35mm) color and color-infrared photography will be acquired as well as conventional, cartographic-quality color infrared aerial photography in association with Landmaelingar Íslands. Time will also be devoted to the revision of various manuscripts and the drafting of new ones.

7. Preliminary research was begun on the measurement of local relief of a mountain in northern Iceland (65°N. latitude) with photogrammetric instrumentation. Some success was achieved with ERTS-1 imagery of a mountain which stands 1,000 m above the surrounding terrain. This work will be continued during the next reporting period.

e. Discussion of significant scientific results and their relationship to practical applications or operational problems including estimates of the cost benefits of any significant results:

There is no question that a low sun angle (as low as 7°) on ERTS-1 imagery, particularly when the terrain is snow-covered, markedly enhances subtle geologic structure and landforms. A small geothermal area (approximately 2.5km^2 in area with an estimated heat flow of 25-125 x 10^6 cal/s.) was recorded on ERTS-1 imagery from the snowmelt pattern. Hot springs, discharging into frozen lakes, form an ice-free area which can be easily seen on ERTS-1 imagery. In colder climes this finding could serve as a useful exploration tool in the search for exploitable geothermal areas. The ice breakup on a small lake was recorded. In remote areas ERTS-1 imagery can therefore be used in climatologic studies by using the time of lake ice freeze-up and break-up as a measure over large areas. Most of the ERTS-1 imagery which included the area of the erupting volcano, Kirkjufell, on the island of Heimaey, was cloud-covered. Of the 14 possible images, only 3 are usable for study, and one image is a pre-eruptive view of the island. ERTS-1 provides a powerful new tool for volcanologists to study erupting volcanoes: new deposits, whether lava flows or tephra falls, and the direction and areal distribution of the eruption plume. Some success was achieved in a preliminary study, using photogrammetric instrumentation, of measuring relative elevation of mountains using ERTS-1 imagery of Iceland, where considerable overlap exists in successive orbits. An object is imaged on 3 successive orbits at the latitude of Iceland (65°N. latitude). (About 130km baseline separation between the "first" and "third" orbits.) Sufficient parallax separation existed on a mountain with 1,000 m of local relief to warrant additional research on the use of ERTS-1 imagery to measure local relief differences of such magnitudes. [2D, 2I (photogrammetry), 3C, 3F, 3I, 3K, 3L (Disaster assessment), 4I, 5D, 7A, and 10A].

f. A listing of published articles, and/or papers, pre-prints, in-house reports, abstracts of talks, that were released during the reporting period:

Williams, R. S., Jr., 1973, Disaster in Iceland: Letter published in Geotimes, v. 18, no. 5, May, p. 9.

g. Recommendation concerning practical changes in operations, additional investigative effort, correlation of effort and/or results as related to a maximum utilization of the ERTS system:

1. The lack of available ERTS-1 imagery (MSS) to carry out the sea ice experiment necessitates the requirement for an enlargement of the test site to include the area west, northwest and north of Iceland for a retrospective order of selected ERTS-1 imagery. This request has been documented in the Data Analysis Plan (dated 1 June 1973) submitted to Goddard Space Flight Center. The modified sea ice experiment will utilize ERTS-1 imagery of sea ice buildup and movement away from the Greenland coast over time (September through October, then late February until tape recorder malfunction). Only selected (low cloud cover) ERTS-1 images will be used.

2. The repetitive ERTS-1 imagery (MSS) acquisition over Iceland has created a large cataloging problem. For that reason a geographic matrix for Iceland has been created to place each image in its proper geographic area. The attached matrix shows how each image (and repetitive images of the same area) has been arbitrarily given a specific geographic name. [Computers handle numbers rather well; most humans conceptually prefer an areal connotation to a particular image.] Each matrix square (image) contains one or more images of pretty much the same area. Successive images differ only in their date (season) and the amount of cloud cover (obscuration). The handling of ERTS-1 imagery then becomes quite similar to map or aerial photo handling. (Maps are generally on a quadrangle basis keyed to geographic coordinates, an index map of a state, county, etc.; aerial photos are generally keyed to a mosaic which is in turn based on geographic coordinates or to a county, state, etc.)

In a true sense, then, the arbitrary geographic matrix for ERTS-1 imagery of Iceland becomes a series of "quadrangle maps," easy to fit into existing map and aerial photographic coverage. NASA should consider holding the orbit quite closely over time (more frequent correction) and holding the "framing" to the same area. In this way successive ERTS-1 (for a specific satellite) images would become "maps" of

specific areas. Study of dynamic phenomena ("change detection") could be more easily carried out, particularly computer-assisted "change-detection mapping."

h. A listing by date of any changes in Standing Order Forms:

None.

i. ERTS Image Descriptor Forms:

One form provided as attachment to this report.

j. Listing by date of any changed Data Request Forms submitted to Goddard Space Flight Center/NDPF during the reporting period:

Separate Data Request Forms were submitted through Arthur Fihelly on 10 May 1973 and through Fred Gordon on 11 and 18 June 1973.

ERTS IMAGE DESCRIPTOR FORM

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NDPF USE ONLY
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ID

DATE 1 July 1973

PRINCIPAL INVESTIGATOR Richard S. Williams, Jr.

GSFC IN 079

ORGANIZATION U. S. Geological Survey

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
1048-12080-5				Caldera Active Volcano EEO Active Glacier (Icecap) EEO Outlet Glacier Braided Stream EEO End Moraine Crater Moraine Outwash Plain Snow Volcano Maar Lava Flows Nunatak
1048-12080-B				Rangeland

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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301-982-5406

GSFC 37-2 (7/72)

NDPF Computer Abscissa

133	119	105	91	77	63	49	35	21	7	
A1	A2	A3 KOLBEINSEY	A4	A5 SLÉTTUGRUNN	A6	A7	A8	A9	A10	A
B1	B2	B3 SKAGI	B4 EYJAFJÖRÐUR	B5 TJÖRNES	B6 AXARFJÖRÐUR	B7 MELRAKKAS-LÉTTA	B8 LANGANES	B9 LANGANES-GRUNN	B10	B
C1	C2	C3 HVAMMS-FJÖRÐUR	C4 LANGJÖKULL	C5 AKUREYRI	C6 MÝVATN	C7 ÓDÁÐAHRAUN	C8 LAGARFLJÓT	C9 SEYÐIS-FJÖRÐUR	C10 GLETTINGA-NES	C
D1 JÖKUL-DJÚP	D2	D3 REYKJAVÍK	D4 THING-VALLAVATN	D5 HEKLA	D6 THÓRISVATN	D7 VATNAJÖKULL	D8 INGÓLFS-HÖFÐI	D9 HÖFN	D10	D
E1 ELDEYJAR-GRUNN	E2	E3 SKERJADJÚP	E4 GRINDA-VÍKURDJÚP	E5 SURTSEY	E6 VEST-MANNAEYJAR	E7 VÍK	E8 KÚÐAFLJÓT	E9	E10	E
F1 ATLANTS-HAF(SV)	F2	F3	F4	F5	F6	F7	F8 SKAFTÁRDJÚP	F9	F10	F
1	2	3	4	5	6	7	8	9	10	

13 14 15 16 17 18

NDPF Computer Ordinate

Iceland Project Ordinate

Iceland Project Abscissa

Iceland ERTS-1 Data Acquisition Matrix

GEOGRAPHIC NAMES FOR ERTS-1 IMAGERY OF ICELAND