TECTONIC MAPPING IN ALASKA WITH ERTS-1 IMAGERY

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16. Abstract

A mosaic of ERTS-1 imagery for a portion of Interior Alaska covering approximately 57,000 km^2 has proved to be a valuable tool in identifying structural elements previously not recognized. Mapped faults are clearly recognizable and are found to be part of a larger system of faults and lineaments identified on the imagery. A previously unrecognized set of conjugate fractures imply regional compression in a NNW-SSE direction in agreement with known fault dislocations. Earthquakes have a marked tendency to occur at intersection of lineaments seen on the imagery.

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TECTONIC MAPPING IN ALASKA WITH ERTS-1 IMAGERY

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ERTS-1 imagery is proving to be a vital tool in mapping many of the complex tectonic features of Alaska with a minimum of time and effort. The following sections outline some typical examples of structural elements that are being recognized for the first time.

1. Faults in central Alaska

The accompanying photographs are a stereo pair of an area in central Alaska measuring approximately 240 kilometers on a side. They were produced from mosaics of portions from 9 ERTS-1 images collected as the satellite was precessing westward during three consecutive revolutions (3, 4, and 5 November 1972; image ID numbers 1103-20495, 1103-20502, 1103-20504, 1104-20554, 1104-20560, 1104-20563, 1105-21012, 1105-21015, and 1105-21021). Multi-spectral scanner band 7 images (near infrared, 0.8-1.1μm) were selected for construction of the mosaics, due to their superior haze-cutting characteristics. Fairbanks is at the right center in the photographs, the Yukon River enters the scene at the top, the Tanana River crosses from right to left, and the Alaska Range is at bottom right. Sun elevation over most of the area was about 9°, all streams and lakes were frozen, and there was a light ground cover of snow. True north and sun azimuth are shown on the overlay. Tectonic features which can be identified fall roughly into one of three catagories.

First, faults which have been previously mapped on the ground are shown as solid lines on the overlay. In general, these are members of a large-scale strike-slip fault system which traverses the state in a roughly east-west direction. Although not always topographically well-defined, large offsets

have occurred along most of these since the beginning of the Cretaceous period, but they now appear to be relatively dormant.

Second, the lineaments shown as dashed lines on the overlay are other large-scale faults, not previously recognized, which appear to supplement the known set. These were probably formed at about the same time as the mapped faults. Included in this category is the northern escarpment of the Alaska Range, which appears on the imagery to be a normal fault with considerable vertical displacement. Some workers disagree with this, however, and attribute this lineament to folding. It is difficult to reconcile the latter mechanism as being the sole agent responsible for this striking feature.

Third, a very fresh set of conjugate fractures, not previously recognized, is shown as dotted lines on the overlay. These intersect at an angle of about 55° and appear to be the result of compressive stress in a NNW-SSE direction. This is roughly the dihedral angle at which most brittle substances would be expected to fail under axial compression, with left-lateral offset on one set of fractures, and right-lateral offset on the other. The persistence of the features over large areas implies that they are continuous beneath the alluvium of the Tanana River Valley. These lineaments are totally different in orientation and geomorphic expression from the other faults on the map, and clearly supersede those older features. Evidently, a major change in the stress system effecting tectonic deformation in Alaska has occurred in the interval between the formation of the different sets of lineaments.

2. Association of earthquakes with faults

Most of the area shown in the photographs is seismically active. The

frequency/space distribution of earthquakes here (about 4/1000 km^2/yr for magnitude $\geq$ 3) is one of the highest in the world, and specific seismically active areas can generally be associated with one or more of the lineaments on the mosaic. The following table lists some of the larger earthquakes to occur in this area during recent years, and these are keyed by number to their respective epicentral location on the overlay.

	Date	Latitude (N)	Longitude (W)	Magnitude
1.	21 Jun 67	64.8°	147.4°	6.0
2.	29 Oct 68	65.4°	150.0°	6.5
3.	21 Jun 69	65.2°	147.6°	4.6
4.	9 Jun 70	64.9°	148.7°	4.2
5.	15 Aug 72	65.2°	148.7°	5.1

The second event on this list occurred on a member of the conjugate fault system discussed earlier. It was a product of left-lateral slip on the north-south trending fault. This is the nature of offset which would be expected on this member of the set under compression of the type postulated. Note further that these events all lie at or near intersections of prominent lineaments or mapped faults. It would therefore appear that earthquakes in this part of Alaska are the result of a stress system which is affecting the region more-or-less uniformly, and that the seismicity of central Alaska may be conceptually regarded as being the product of the grinding together of relatively rigid blocks, with earthquakes occurring along their common boundaries, and at the intersections where three or more blocks come together.

The practicality of using ERTS imagery for the purposes of geologic and tectonic mapping is evident. Findings such as these would have taken many man-years in the field.

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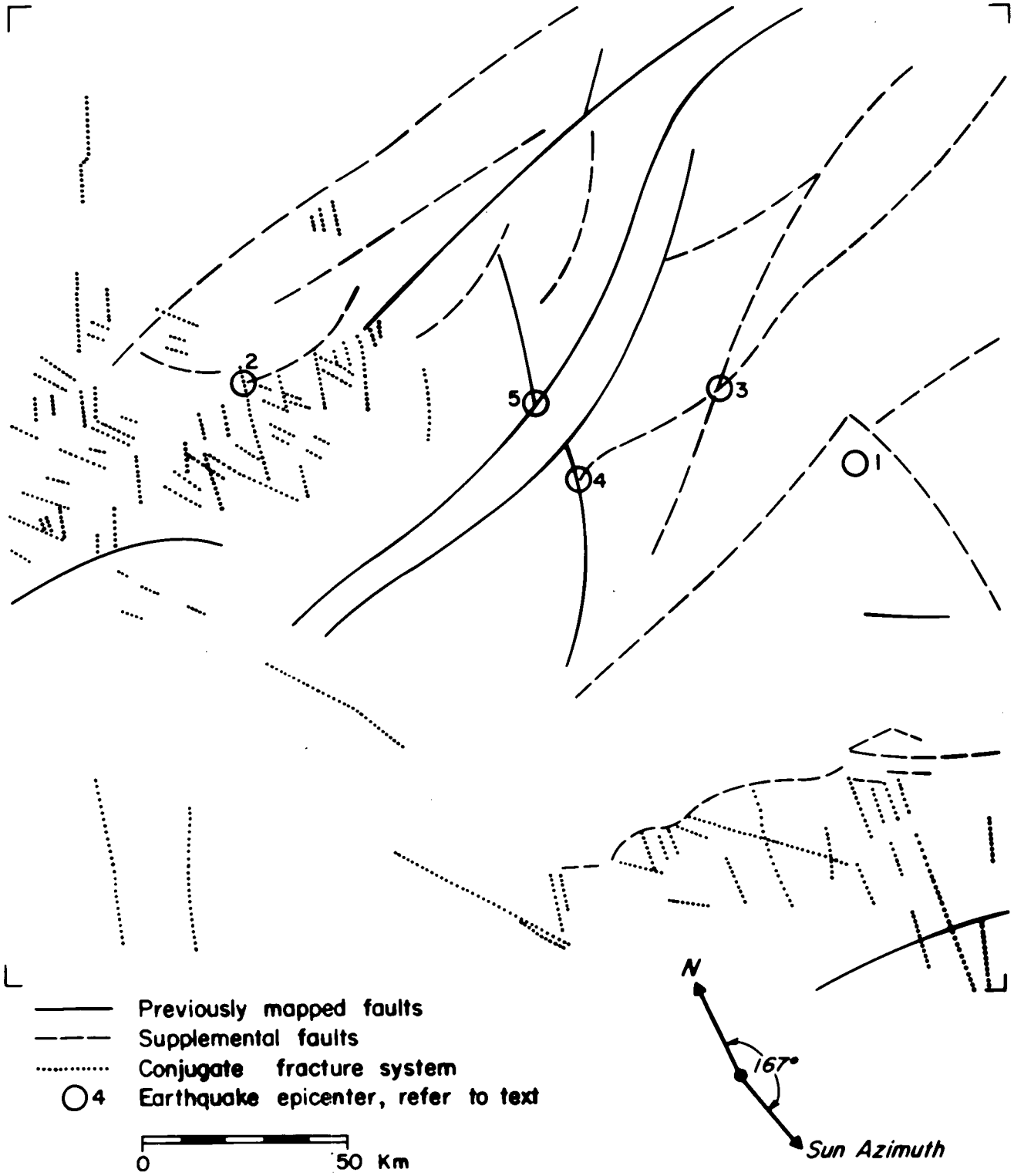
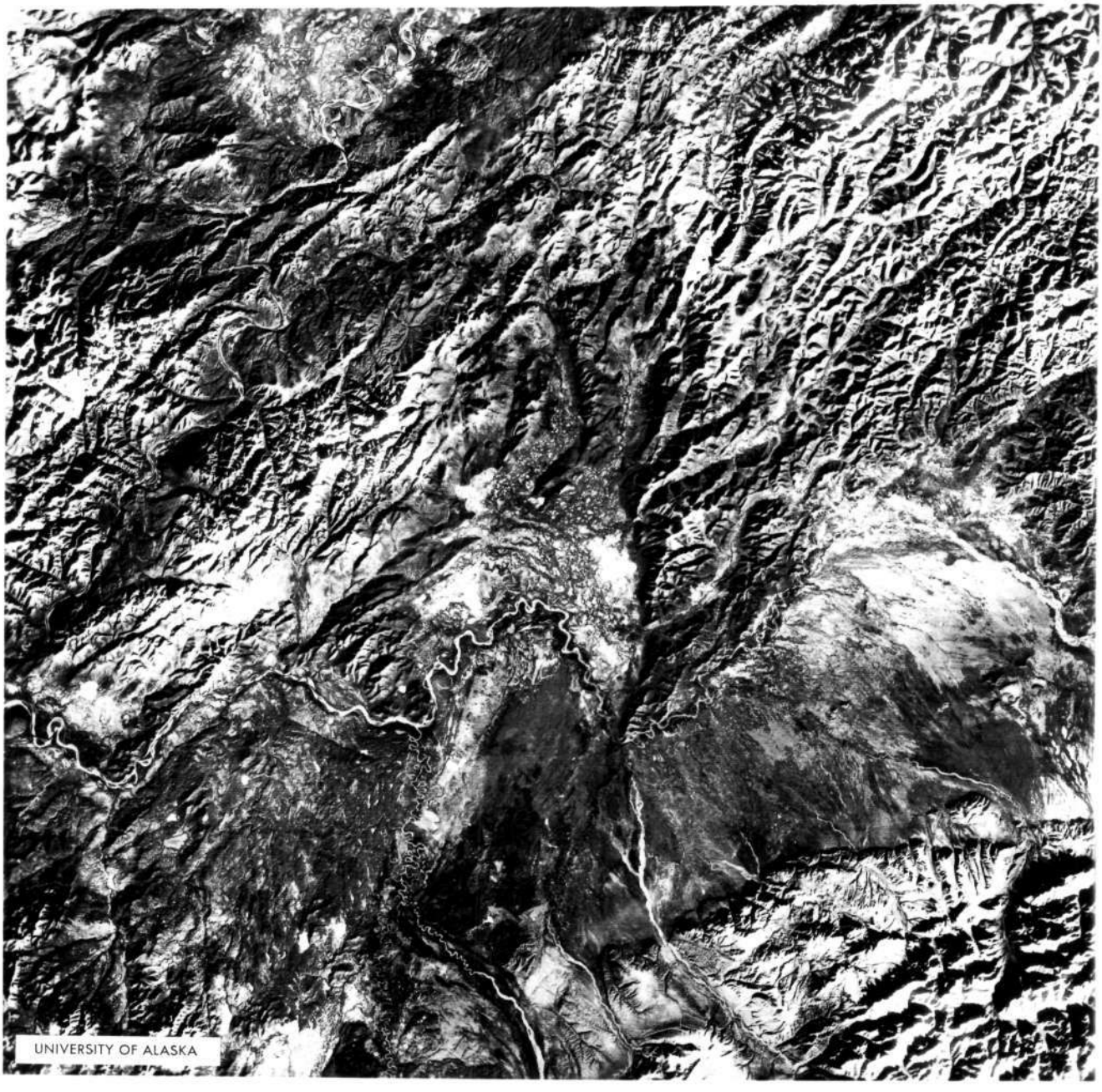

2
5
3
4
1
Previously mapped faults
Supplemental faults
Conjugate fracture system
4 Earthquake epicenter, refer to text
0
50 Km
N
167°
Sun Azimuth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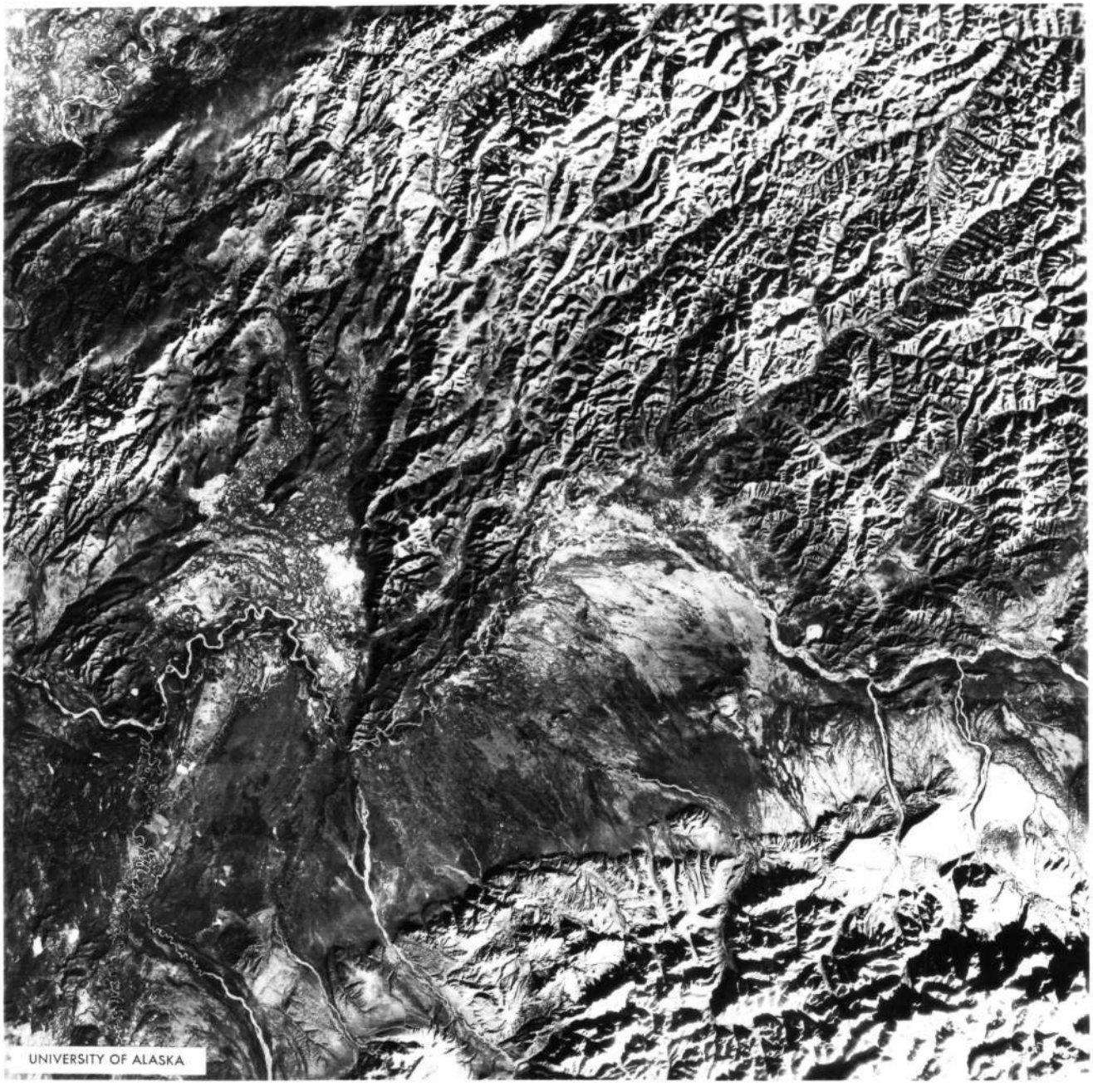
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