

26 km of Offset on the Lake Clark Fault Since Late Eocene Time

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Abstract

Aeromagnetic data over the Lake Clark Fault reveal a north-trending band of magnetic anomalies that are right-laterally offset about 26 km across the fault. The magnetic anomalies correlate spatially with a belt of dated 34–39-Ma granitic plutons. Thus, the Lake Clark Fault has had ~26 km of right-lateral offset in the past 34–39 Ma. The Castle Mountain Fault, which lies along the strike of the Lake Clark Fault to the east-northeast, must have had a similar or, possibly, greater amount of offset. We infer the presence of an additional right-lateral strike-slip fault about 35 km northwest of the Lake Clark Fault, herein named the “Telequana Fault,” on the basis of 11 km of right-lateral offset of a north-trending band of magnetic anomalies.

Introduction

Quantifying the amount of offset on faults in Alaska has been elusive, owing to the reconnaissance nature of geologic mapping, the remoteness of field areas, and the difficulty of finding piercing points across faults. The largest strike-slip fault systems in the main part of Alaska are, from north to south, the Tintina-Kaltag Fault, the Iditarod-Nixon Fork Faults, the Denali-Farewell Fault, the Lake Clark-Castle Mountain Fault system, the Bruin Bay Fault, and the Border Ranges Fault (fig. 1). In this chapter, we utilize aeromagnetic data to constrain the offset on the Lake Clark-Castle Mountain Fault system since late Eocene time, refine the position of the Lake Clark Fault, and identify an additional right-lateral strike-slip fault to the northwest.

Interpretation of Aeromagnetic Data

During our investigation of new aeromagnetic data from the Cook Inlet region (Saltus and others, 2001) and surrounding area (Saltus and others, 1999), we found a magnetic high that parallels the trace of the Castle Mountain Fault across the Susitna Lowland, and lies beneath a 3- to 4-km-wide anticline just north of this fault (Haeussler and others, 2000). The

magnetic high extends southwestward toward the Lake Clark Fault (fig. 2), as previously mapped by Barnes (1966) and Detterman and others (1976). A connection between the Lake Clark and Castle Mountain Faults was first inferred by Detterman and others, because both faults have the same orientation and trend into each other west of the Susitna River. (However, Barnes, 1966, mapped the “Castle Mountain Fault” in the region between the Chakachatna and Theodore Rivers, which Detterman and others, 1976, later considered to be a section of the Lake Clark Fault.) The new aeromagnetic data confirm Detterman and others’ interpretation, with some modification.

The Lake Clark Fault appears as a linear magnetic low northwest of Cook Inlet (Case and Nelson, 1986). The previously mapped trace of the Lake Clark Fault (Nelson and others, 1983) west of long. 153°15′W. does not match the position of this linear magnetic low (between arrows 1 and 4, fig. 2). Thus, we infer that the fault was previously mismapped in a remote region consisting of mountains, glaciers, and granitic plutons of different ages which are compositionally similar (Reed and Lanphere, 1967). The aeromagnetic data, however,

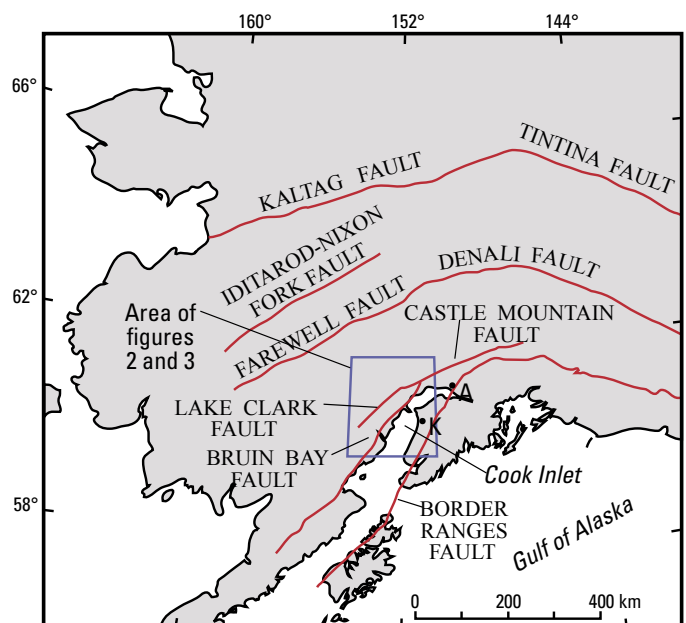


Figure 1. Southern Alaska, showing locations of large strike-slip faults. A, Anchorage; K, Kenai.

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do not preclude minor offset along the previously mapped trace of the fault.

Reed and Lanphere (1967, 1973) identified numerous Late Cretaceous through Paleocene (~57–72-Ma K-Ar ages) and Oligocene (34–39-Ma K-Ar ages) granite, granodiorite, quartz monzonite, and diorite plutons in the region (fig. 1; see Magoon and others, 1978, for ages with revised decay constants). The aeromagnetic map (fig. 2) shows that areas of dated Late Cretaceous through Paleocene plutons have relatively low induced magnetizations, in contrast to areas of dated Oligocene plutons that correlate with strong magnetic

highs. An area of northeast-southwest-trending magnetic highs indicates a corresponding swath of Oligocene plutons more extensive than previously mapped. This area of northeast-southwest-trending magnetic highs intersects and is offset along the Lake Clark Fault. The offset of the maximum gradient of induced magnetization provides piercing points (arrows 1–4, fig. 2) across the Lake Clark Fault with offset of 26 km since 39–34 Ma.

We infer the presence of another fault northwest of and parallel to the Lake Clark Fault (fig. 2). Case and Nelson (1986) noted this feature and considered it to be a “magnetic

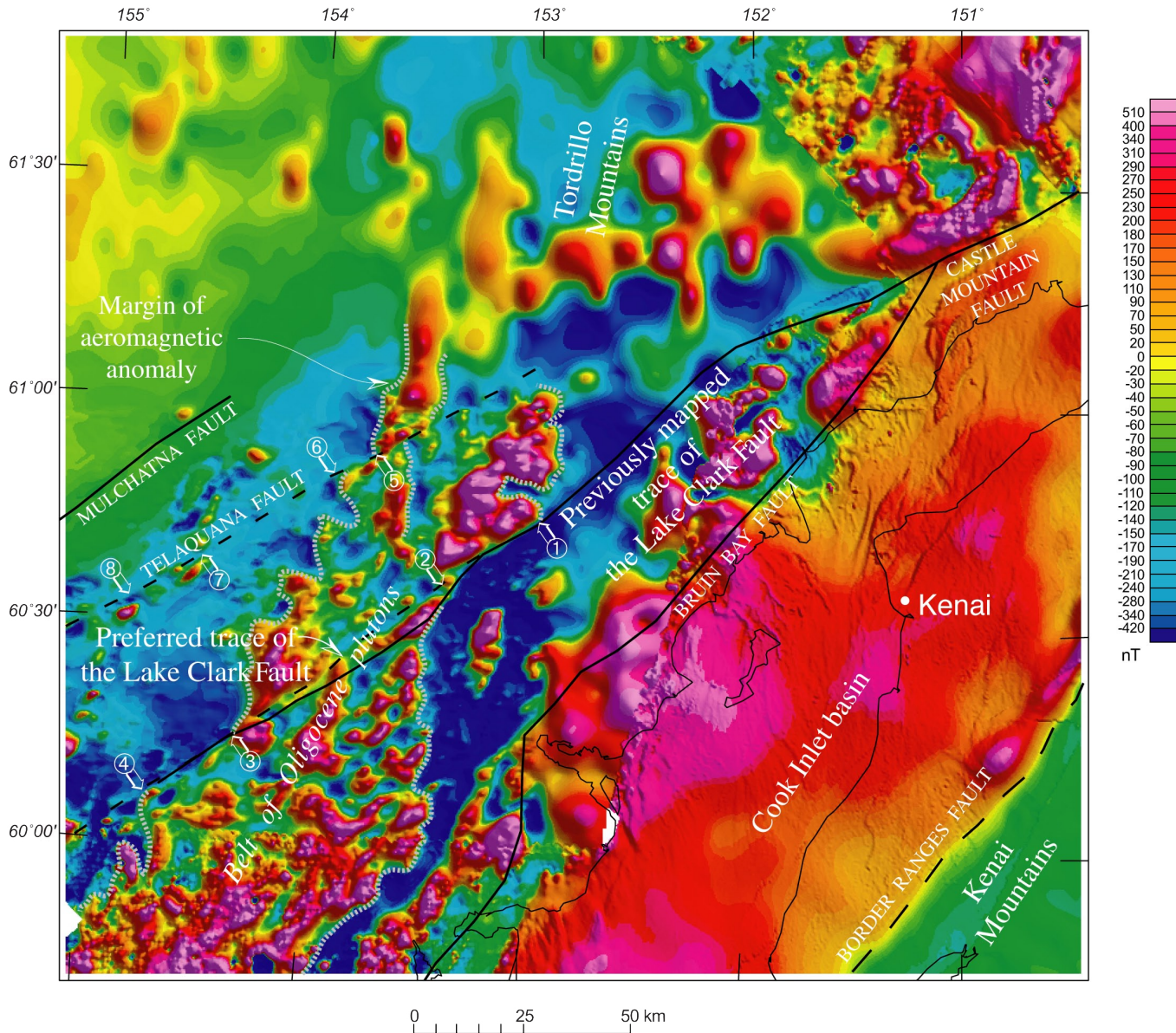


Figure 2. Aeromagnetic map of part of south-central Alaska from compilation by Saltus and others (1999) and new data (Saltus and others, 2001), showing residual total-field magnetization with International Geomagnetic Reference Field values removed. Note varying resolutions of merged aeromagnetic surveys. Numbered arrows denote interpreted piercing points across fault traces; dotted gray lines show gradients at margins of magnetic regions.

lineament.” This fault also appears as a linear magnetic low that offsets the belt of Oligocene plutons. We propose calling this linear feature the Telaquana Fault because of its proximity to the headwaters of the Telaquana River and Telaquana Pass. The fault shows piercing points (arrows 5, 6, fig. 2) with an offset of about 11 km. We infer with less confidence that the fault extends southwestward. A north-northeast-trending linear belt of magnetic highs, which corresponds to a belt of mapped Cretaceous or Tertiary intrusive bodies (fig. 3; Nelson and others, 1986), along the fault shows piercing points (arrows 7, 8, fig. 2) with an offset of about 10 km.

Discussion

Plafker and others (1975) inferred that right-lateral offset on the Lake Clark Fault occurred after 38 Ma, on the basis of offset of the intrusive contacts of a dated pluton. Our interpretation of the aeromagnetic data supports their conclusion of right-lateral offset; however, they inferred only 5 km of offset—much less than our estimated 26 km. We consider the offset of the linear belt of magnetic highs to be a stronger piercing point than outcrop data along one section of the fault. We suggest that the intrusive contacts they observed on each

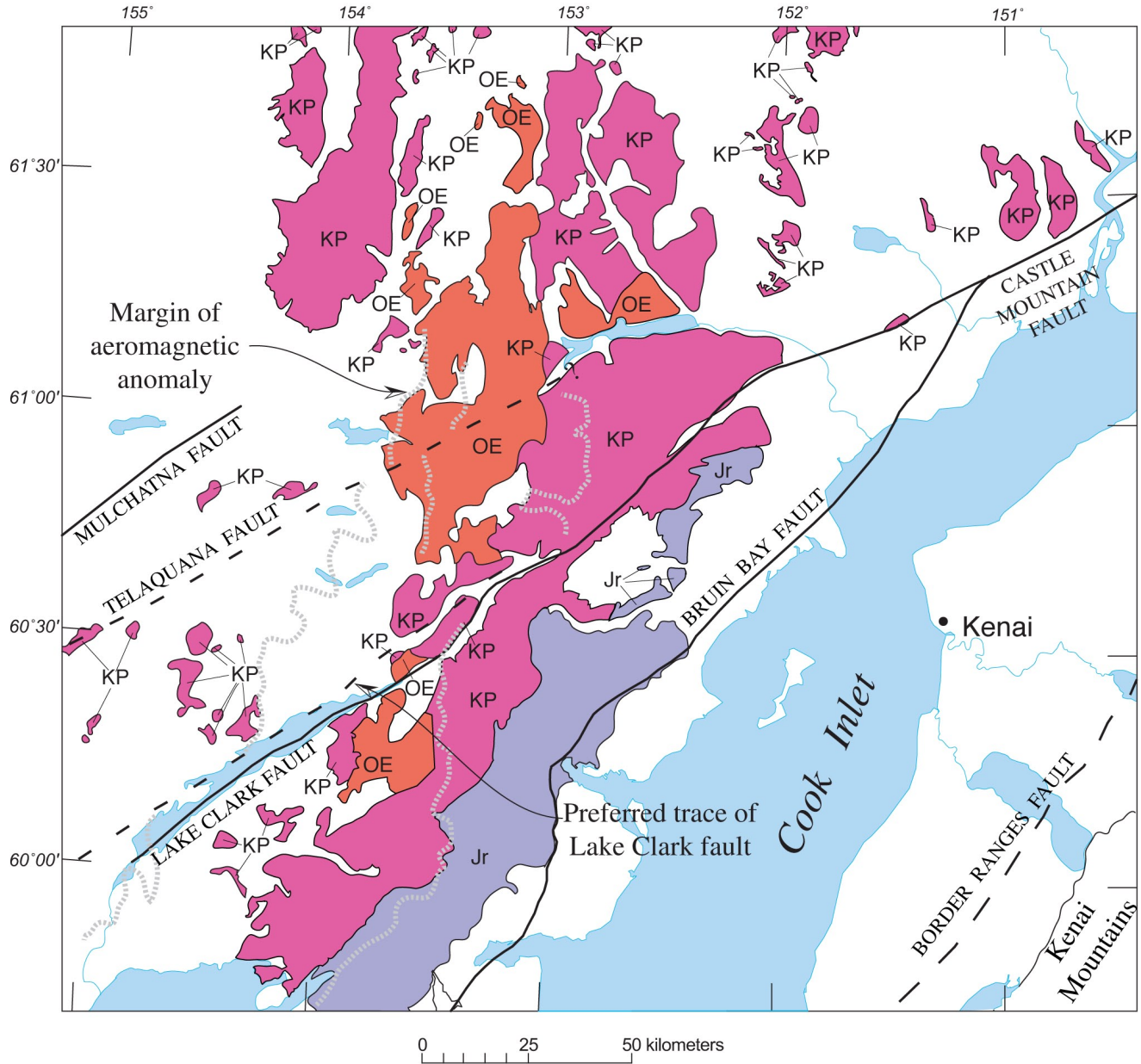


Figure 3. South-central Alaska, showing locations of Jurassic (Jr), Cretaceous-Paleocene (KP), and Oligocene-Eocene (OE) intrusive bodies, simplified from compilation by F.H. Wilson (unpub. data, 1999), Detterman and Reed (1980), Magoon and others (1976), Nelson and others (1983), and Wilson and others (1998). Dotted gray lines show gradients at margins of magnetic regions.

side of the fault were not correlative. In addition to the right-lateral strike-slip offset, Detterman and others (1976) also inferred northwest-side-up reverse motion of about 500 to 1,000 m on the basis of offset Tertiary strata near Cook Inlet.

A total of 26 km of right-lateral offset on the Lake Clark Fault in the past 34–39 Ma implies a similar offset on the Castle Mountain Fault. No other constraints on the total strike-slip offset on these faults in Mesozoic or Tertiary time are known. Haeussler and others (2000) outlined evidence indicating that Pliocene and Pleistocene right-lateral movement on the Castle Mountain Fault was transferred into right-transpressional deformation in fault-cored folds in the Cook Inlet basin. If so, the movement on the Castle Mountain Fault since 38 Ma would have exceeded the 26 km of offset on the Lake Clark Fault, but not by more than 5 to 10 km—an approximate estimate of total shortening across the structures in Cook Inlet in late Tertiary time.

The Denali Fault has had 38 km of offset in the last 38 Ma (Reed and Lanphere, 1974), similar to the combined offset on the Lake Clark and Telaquana Faults. This coincidence in the amount of offset might imply a similar magnitude of dextral shear from south-central Alaska to the north side of the Alaska Range and is also consistent with the oroclinal “megakink” hypothesis of Coe and others (1986). Alternatively, the near-equality of offset on these two fault systems may be coincidental. Nonetheless, this evidence for post-38-Ma offset on the Lake Clark and Telaquana Faults strengthens the evidence for widespread dextral shear along the southern Alaska margin in middle to late Tertiary time.

Acknowledgments

We thank Dwight Bradley and George Plafker for their constructive reviews of the manuscript, and Lana Cohen for her help in drafting the geologic map.

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