Introduction

The proposed route of an inviable natural gas pipeline extending from Prudhoe Bay to Anchorage, Alaska, involves a variety of geologic environments and presents significant challenges for pipeline engineers. Thus, accurate tectonic evaluation and characterization of geologic hazards is a critical component to pipeline route selection, design, and construction. Geologic hazards that can potentially affect pipeline routing and design include, among others, active faulting, earthquake ground shaking, landslides, rockfall, thawing permafrost, and flooding.

The Alaska Division of Geological & Geophysical Surveys (DGGS) is conducting a phased study to systematically evaluate tectonic hazards along the entire proposed pipeline route. Our investigational approach includes map and data compilation, assessment of geologic data, acquisition and evaluation of high-resolution lidar data, and field characterization of geologic hazards.

Here we present:
- Observations from field investigations and interpretations of the first field data acquired along the Castle Mountain fault;
- several techniques useful for characterizing fault geometry and displacement paramaters;
- several possible analogs to evaluate the style of deformation along the Castle Mountain fault.

The new field data and our observations have profound implications regarding the width of deformation and the style of faulting along the Castle Mountain fault and are important for pipeline routing and design. Additionally, these data will help refine slip rate and recurrence estimates that are of critical importance for seismic hazard assessments for the greater Anchorage metropolitan area.

Tectonic setting and Castle Mountain fault

Compression and shear across southcentral Alaska are driven by north-northwest relative motion (~55 mm/yr) between the Pacific and North American plates along the Fairweather Fault, Yakutat microplate, and Aniakchak subduction zone. Subduction of the relatively buoyant Yakutat microplate has resulted in development of the Chugach, St. Elias and Treadwell and associated left-lateral rupture of the Wrangellia microplate, the region of crust in southcentral Alaska between the Chugach Mountains and the Alaska Range. Geodetic studies indicate that the Wrangellia microplate is rotating towards the southeast at a rate of 0.2-0.3 mm/yr (Haeussler et al., 2002). Thus, the Castle Mountain fault, the Bluff Creek fault, and the Turnagain thrust all have lateral slip rates ranging from one to four, and the lateral slip rate varies from 0.3 to 3 mm/yr.

The Castle Mountain fault has been characterized as both a thrust fault and a strike slip fault, the number of late Holocene earthquakes (Haeussler et al., 2002). A late Pleistocene-Holocene right lateral slip rate of 2-3 mm/yr was estimated by Freymueller et al. (2008). To the north, the Denali-Totchunda fault system accommodates this rotation by 4-5 cm/yr of dextral shear along the arcuate southern margin of the Alaska Range and was the source of the magnitude 7.9 Denali earthquake in 1957.

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Implications for pipeline design

The proposed faultplane crossing is currently within a broad fan or zone of stable terrain in the fault zone. Our observations suggest that the fault has only biology surface (or) trace to this location. The shallow slope that marks the fault or the crossing may indicate relatively shallow fault slope and a lateral zone of deformation. Thus, there is considerable potential for damage to pipelines at shallow depth. We suggest the possibility that the Castle Mountain fault has generated only one large surface rupture in the past 7,000 yrs, whereas geologically recent faulting has occurred in the past 2,000 yrs.

Field observations along the Castle Mountain fault indicate that the fault is a right lateral fault with a slip rate of about 2-3 mm/yr. Our observations on the style of deformation are consistent with Detterman et al. (1974) and Haeussler et al. (2002), but differ from the reports of Willis et al. (2007) in some aspects of the boundary fault analysis and field observations. We would like to invite the neotectonic community to consider a reclassification of the Castle Mountain fault as an oblique right reverse fault with a lateral slip rate similar to its long term rate of ~0.5 mm/yr. This fault may be similar to the examples shown below.

Possibility to avoid the Castle Mountain fault

Seismic Hazard Map update for Alaska shows realistic ground motions related to earthquakes on the Castle Mountain fault crossing location and design. By selecting a location where the fault trace is narrowly confined, the width, width of deformation at the current crossing. Our fault lineament mapping is being used to determine the best fault.

What is the paleoseismic evidence for the Castle Mountain fault?

Based on the fault morphology, rupture geometry, and continuity of stream channel margins across the Castle Mountain fault, it appears to be a relatively young fault located on the late Holocene. It further suggests that the greater north of the fault are the point of folding and separation in the south of an active evidence in the hanging wall of it is a reverse slip fault. The left slip displacement of these features is consistent with a component of oblique slip, however we did not observe lateral displacement of longitudinal markers. Thus, we would change the current Castle Mountain fault strike-slip paradigm.

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1. How will the study of the Castle Mountain fault as a barrier to pipeline crossing will be conducted?
2. What kind of data will be collected in the study?
3. What tools will be used for data analysis?
4. How will the results be used for pipeline design?
5. What are the implications of the study on the future of pipeline planning in the region?