



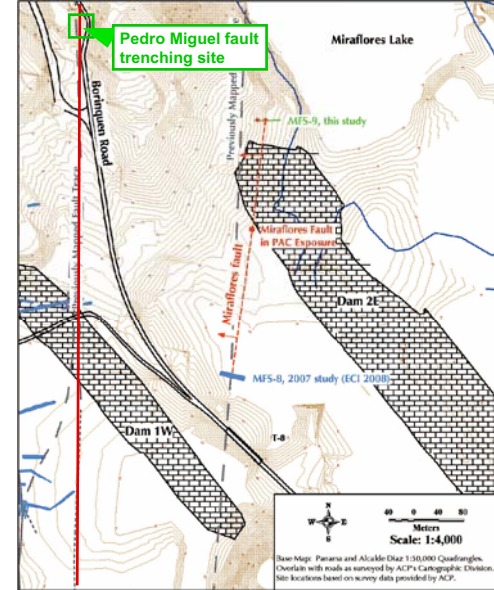
QUANTITATIVE FAULT RUPTURE CHARACTERIZATION FOR DESIGN OF THE BORINQUÉN DAM, PANAMÁ CANAL EXPANSION PROJECT, PANAMÁ

PROJECT DESCRIPTION

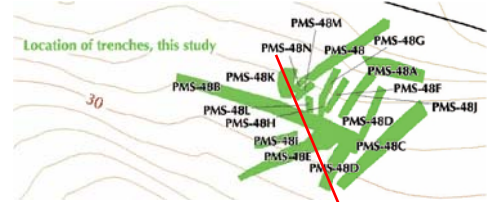
As part of the design studies for the Panamá Canal Expansion Project, the Autoridad del Canal de Panamá (ACP) authorized **Earth Consultants International (ECI)** to undertake a quantitative investigation to determine the rupture kinematics of the Pedro Miguel fault at the location where it crosses under the proposed foundation of Borinquén Dam. The fault was initially determined to pose a seismic shaking hazard, which was quantitatively determined through detailed paleoseismic trenching studies in a prior phase of work. In another prior phase of work, the Pedro Miguel fault was confirmed to be the causative source for the destructive Panamá Viejo earthquake of May 2, 1621. The purpose of this study was to document and measure as precisely as possible the fault offset from that most recent event as a proxy for the most likely future event. The displacement magnitude and sense of offset would become the preferred values for use in design of the Borinquén Dam to resist that future event.

SOLUTION

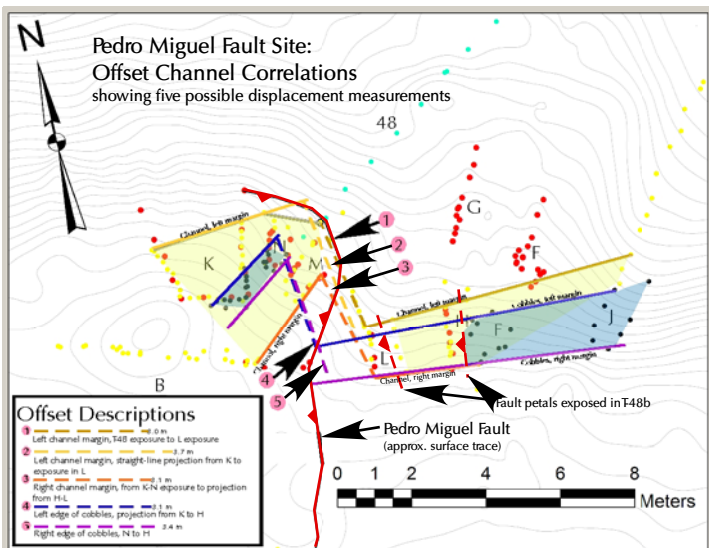
The investigation targeted a fluvial channel which appeared to be right-laterally offset 3–4 m where it crossed the Pedro Miguel fault trace. The intent was to precisely locate the fault on both sides of the channel margins, then progressively excavate the channel margins closer and closer to their eventual fault contact. Unfortunately, the site was scheduled for excavation as part of the dam construction, so time was of the essence in completing this study. With dedicated survey assistance from ACP, we were able to excavate, log, and analyze 15 trenches in less than two weeks, despite several days of intense rainfall. The fault is expressed in the near surface as a complex, en-echelon stepping set of shallowly dipping petals. The channel margins were determined to be offset 3.0 ± 0.2 m right-laterally and 0.5 ± 0.5 m vertically in a reverse sense within 5 m of the fault tip. These displacements were incorporated into the dam's design.



Trenching location within the center of the proposed Borinquén Dam, adjacent to Miraflores Lake. The Miraflores fault was also investigated in a parallel study.



Map of trenches excavated.



Map of the offset channel margins, showing several channel reconstruction alternatives. The best fit reconstruction was 3.0 ± 0.2 m.

Trench exposure (right) of the most recent event on the Pedro Miguel where the the fault ruptures to the surface, forming a mole track that is still preserved topographically. The channel deposits that we mapped across the fault are shown on the left, about 3 m before they cross the fault and are subsequently offset (left).

