Collection of Potential Fields Data to Constrain Spatial Patterns of Deformation in South-Central, Alaska

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Potential fields data, especially gravity and magnetics, can be used to examine a number of important tectonic processes in the Cook Inlet and Prince William Sound regions of Alaska. Over the past 3 years we have conducted gravity campaigns in the Kenai Peninsula, Anchorage and Mat-Su Valley regions, collecting over 1000 new gravity data points (Figure 1). Our 2009 and 2010 campaigns focused on the Border Ranges fault system, while the emphasis in summer 2011 was on the Castle Mountain fault (CMF). These data are greatly enhancing our understanding of structural controls on the earthquake rupture along the plate interface and subduction processes, the relation of deformation to upper plate geology and structure, and the relation of lower crust/upper mantle serpentinite bodies to fluid migration.

Seismicity within middle Cook Inlet lies within a -75 mGal Bouguer anomaly low and magnetic high that may be related to serpentinized lower crust and upper mantle (Saltus et al., 2001; Haeussler and Saltus, 2001) (see Figure 2). Our 2.5-D modeling of newly acquired and existing gravity data indicates this serpentizined zone narrows to the northeast and ends near the projected subducted southwestern edge of the Yakutat microplate. This is in accord with the model of Haeussler and Saltus (2011) that suggests the subducting Yakutat microplate is less fluid rich than typical oceanic crust and that any fluid flow above the slab is channeled toward the southwest. Haeussler and Saltus (2011) further propose that the presence of fluids within the lower crust and upper mantle in this region has led to the rapid subsidence within upper Cook Inlet basin.

East of the Border Ranges fault (BRF) we observe a Bouguer anomaly high (> -50 mGal) throughout most of the eastern Kenai Peninsula, but a low (< -70 mGal) on the eastern side of the BRF east of Anchorage (Figure 2). We believe this change in gravity reflects the subduction of the less dense Yakutat microplate north of Turnagain Arm.

In the Prince William Sound region shallow (< 15 km) seismicity occurs at the edges of mafic and ultramafic bodies that are delineated at depth by aeromagnetic highs (Doser et al., 2008). The edges of the strongly coupled Prince William Sound asperity correlate well with the edge of the -20 mGal Bouguer anomaly associated with the shallowly dipping Yakutat microplate and Pacific plate beneath the region.

Our recent gravity survey along the CMF (completed mid-August 2011) was motivated by the observation that existing gravity data suggest that most recent seismicity along the fault occurs in regions where the Bouguer anomaly > -70 mGal. In contrast, paleoseismologic studies (e.g. Haeussler et al., 2002) show Holocene slip rates along the fault are higher in regions where the Bouguer anomaly < -100 mGal. Considering that the timing of M>7 events along the CMF appear to be similar to events along the plate interface (Haeussler et al., 2002) we hope the recent gravity data will help us resolve possible structural relationships between the CMF and the plate interface.

It is obvious that potential field data can greatly enhance our understanding of structural controls on the earthquake rupture and subduction processes. Unfortunately, gravity and magnetic data are sparse in many regions of south-central Alaska, and existing data were often collected several decades ago with lower resolution instrumentation and less precisely determined station locations. We propose to collect new gravity and magnetic data in tandem with other planned geophysical and geological studies of this region. This would include collection of marine data in conjunction with any new refraction/reflection surveys in Prince William Sound or Cook Inlet or the deployment of OBS for passive seismic studies. Collection of land data in regions accessible by 4-wheeler, snow machine, boat, float plane or helicopter during deployment of seismograph stations or other geological/geophysical studies would also be advantageous. Critical regions where we lack detailed coverage include much of offshore/onshore Prince William Sound, the southern Kenai Peninsula, the entire Susitna Basin, and the western shore of Cook Inlet

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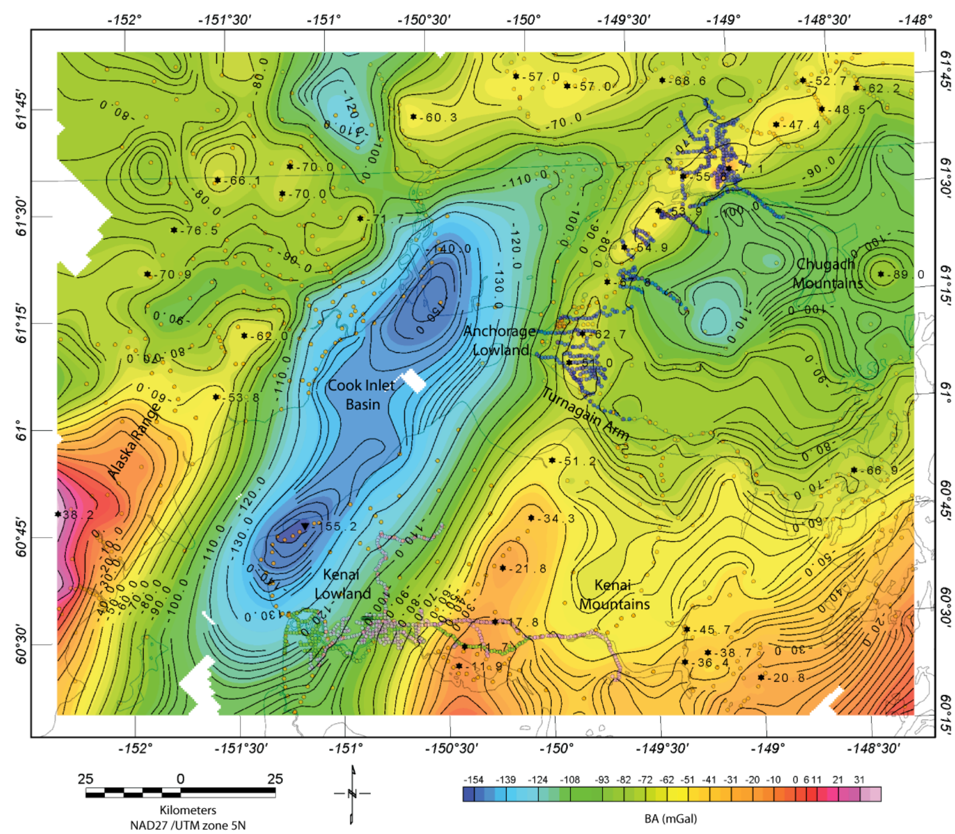

Figure 1 – Simple Bouguer anomaly map (with reducing density of 2670 kg/m^3). Gravity points were compiled from pre-1996 existing data, 2009 (pink and green points) and 2010 (blue points). A survey completed in mid-August 2011 collected ~400 new gravity readings in a region from 61.4 to 61.75°N and 148.7 to 150°W.

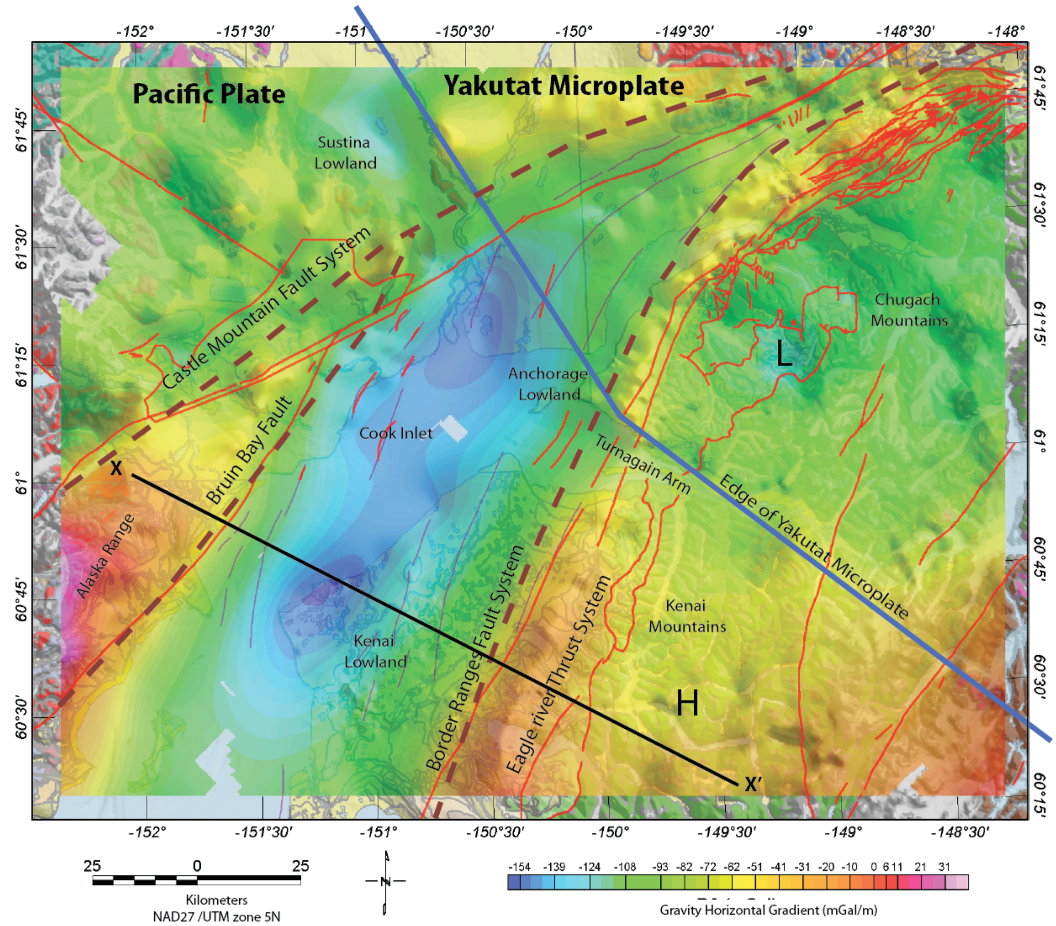

Figure 2. Horizontal gravity gradient compared to subducted edge of the Yakutat microplate (bold blue line, modified from Eberhart-Phillips et al., 2006). Gravity anomaly high (H) and low (L) east of the BRFS appear to be separated by the edge of Yakutat microplate