Oceanic Connections

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While it is assumed that Earthscope is limited to a terrestrial scope, it is also clear that, if successfully launched, it will imply a requirement for a range of activities in adjacent oceanic areas. Particularly the Plate Boundary Observatory component of Earthscope will be dependent on complementary Marine Geology and Geophysics investigations for its success. Many of the necessary oceanic tools of geodesy, seismology and geomorphology already exist and have been applied in limited extent by investigators in areas of PBO interest. It would be appropriate for Earthscope to encourage related investigations in Ocean Sciences by highlighting important questions that can only be answered by correlated marine and terrestrial approaches.

The proposed PBO backbone array provides the most graphic example of the need for oceanic information. As presented at the October, 2000, workshop (van Dam and Agnew, 2000), it would add over 100 new GPS stations to the many already existing in the zone extending inland over 500 km. On the oceanic side of the coastal line, except for the stations on islands in the Southern California Bight and the Farallons, there are exactly three deep sea GPS/Acoustic reference points (Fig. 1; Spiess, et al., 1998, Spiess, et al., 2000) - a meagre start to characterizing the current day oceanic input to North American Plate boundary processes (Fig. 2).

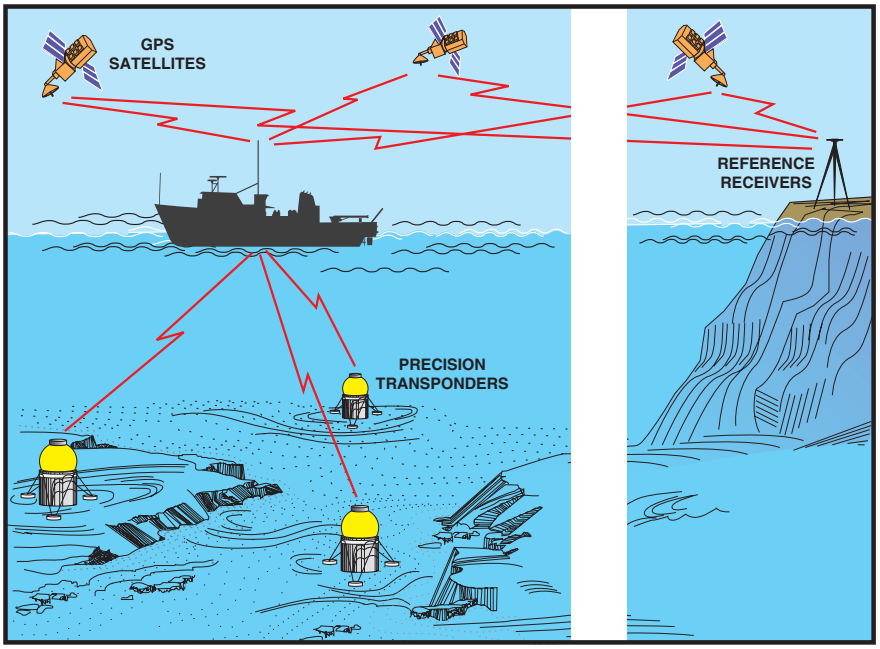

Figure 1. The GPS/Acoustic method measures acoustic ranges from a hull-mounted hydrophone to precision transponders on the sea floor while simultaneously recording GPS data at a triplet of shipboard antennas to define the instantaneous position of the hydrophone. The continuously varying near surface sound speed structure produces coherent travel time variations that are modeled with the result that with 4 days of observations the horizontal location of the seafloor array can be determined with repeatability of ± 1 cm (Spiess, et al., 1998).

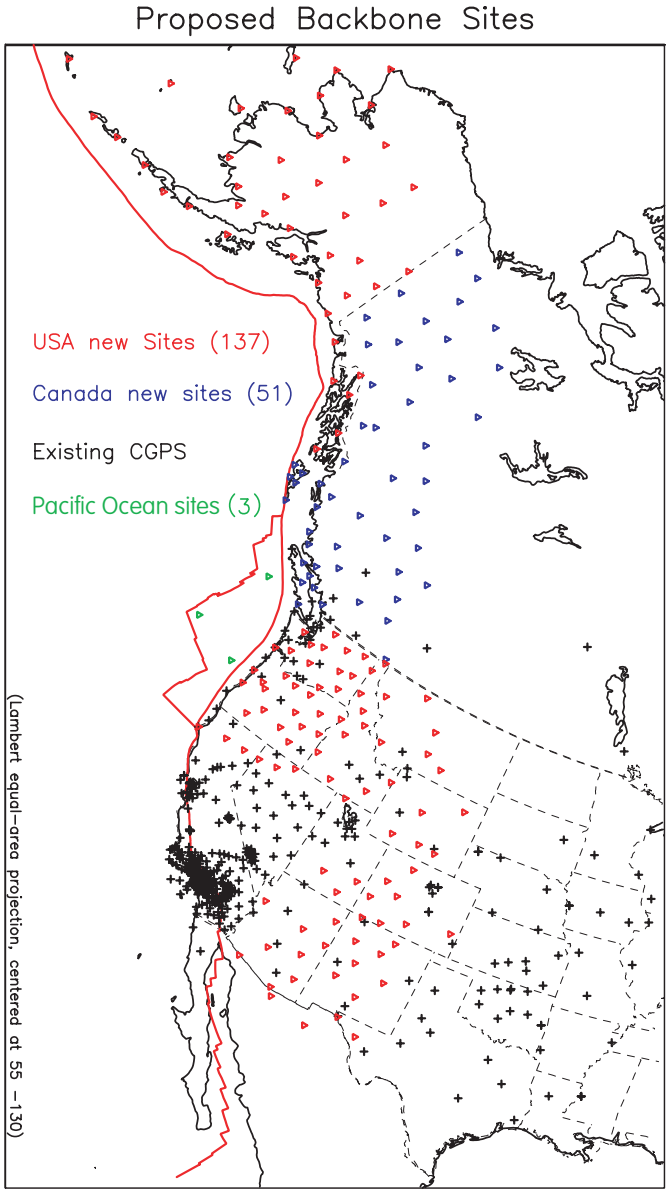

Figure 2. Contrast between the on-shore density of GPS observation sites proposed in the Plate Boundary Observatory (van Dam and Agnew, 2000) and the existing Pacific Ocean site density (Spiess, et al., 2000).

The Cascadia Subduction Zone has been the most intensively studied of any oceanic region abutting the Earthscope domain. Geological insights based on seafloor morphology and seismic reflection surveys have been developed over many years and used in conjunction with similar terrestrial information to build models of the history of the area that are examples of the best work integrating across the sea-land boundary (e. g. Goldfinger, et al, 1997; Hyndman and Wang, 1995; Trehu, et al, 1994). Nevertheless, current interest in how processes evolve on the scale of years or less raises questions that dictate a need for GPS observation points distributed across all of Oregon and Washington (Fig. 2). Similar uncertainties exist on the seaward side of the boundary and should generate complementary pressure to densify GPS coverage, as well as application of other geodetic approaches such as direct strain measuring devices. Given that there are plans being developed for scientific ocean drilling off the Oregon coast, it might be timely to propose installation of borehole strain meters, although that technology has as yet only been applied in the deep ocean in one or two instances off the Japanese coast.

The only other oceanic zone relevant to Earthscope that has drawn significant interest from the MG&G community is the Gulf of California. The NSF MARGINS program has recently held a workshop and is involved in planning an initiative in that area, recognizing it as an example of a rifted continental margin (MARGINS, 2000). If this initiative moves forward successfully it will clearly interact in a significant way with the south-western elements of Earthscope.

The Earthscope plate boundary zone that most requires close collaboration with the marine community, and is of greatest relevance from the viewpoint of current seismic activity, is the extreme northern portion of the San Andreas and the adjacent Mendocino Triple Junction. The Triple Junction area has been the site of 4 earthquakes of greater than magnitude 7 in the last 30 years and is a complex region embodying the poorly defined southern section of the Juan de Fuca Plate (Gorda Plate). The PBO Working Group for the Central and Northern San Andreas Fault System (PBO-WG-CNSA, 2000) notes "This area is one of the most seismically active areas in California. Magnitude 6+ events are relatively common here, making it an attractive area for investigations of time dependent phenomena. However, much of the activity occurs offshore." The SAF immediately to the south of the triple junction has been characterized as a very simple part of the SAF complex - a good site at which to investigate partitioning of strain among several major faults -- San Andreas, Maacama, Bartlett Springs (PBO-WG-CNSA, 2000), with most of the San Andreas being undersea in that area.

Given the seismic risk relevance and the fundamental SAF questions that can be addressed in this region, it is a good area for the initiation of a joint land/sea program. On the oceanic side, improved topographic coverage and seismic reflection profiles are essential, and would provide the base for establishing geodetic reference clusters using both GPS/Acoustic and purely acoustic techniques (Spiess, et al., 1998; Spiess, 1985). It may well be that the

apparent simplicity of the SAF zone here is a consequence of lack of information rather than reflecting the actual nature of the situation. Similarly, lack of offshore information may be responsible for the lack of challenges to the triple junction modelers to develop concepts that include the Pacific Plate (one of the triplet). For example, in their paper modeling the Mendocino Triple junction, Furlong and Govers (1999) state "Although the patterns of crustal deformation are three dimensional, available constraints....do not allow us to constrain and adequately validate a three dimensional model of the process." In any event, determination of the style of motion on the offshore San Andreas itself would not only be of SAF interest, it would provide a useful constraint on models of the triple junction immediately to the north since that fault terminates in some manner in the triple junction zone.

In summary, even though Earthscope may choose not to provide direct support to complementary offshore activities, Earthscope could act as a catalyst to encourage the MG&G community to implement appropriate investigations and should assist in shaping important joint marine/terrestrial initiatives.

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