Where in the world are we going?

Overview:	Combine technology, earth science and math to help your students understand the movement of tectonic plates, with the use of models. Students graphs from GPS station data tables, to relate the direction and rate of motion.
Duration:	Two classes or one class with homework
Objectives: Students will…	• Visualize tectonic plate movement in southwestern Canada including how the Juan de Fuca, Pacific and North American plates interact with one another • Build a model of a GPS station on a tectonic plate and use the model to help visualize the movement of tectonic plates and how GPS technology is used to track movement • Graph GPS data and determine the direction and rate of motion of a GPS station
Vocabulary:	(With help from Clague et al, 2006, At Risk: Earthquakes and Tsunamis on the West Coast.) **Continental crust –** The crust under continents. Rock is less dense and thicker than oceanic crust. **Continental shelf –** Shallow undersea fringe along the edge of the continent, which is part of continental plate. **Continental slope –** The slope leading from the shelf to the deep. **Crust –** The outermost layer of the Earth. **Divergent boundary –** Site of spreading found at sub-sea ridges where two plates form from magma and spread in opposite directions, for example Juan de Fuca and Pacific move east and west from Juan de Fuca Ridge. **Earthquake –** A sudden release of energy from strain built up in the Earth's crust, usually located near plate boundaries. **Global Positioning System (GPS) –** Technology that used to make highly precise measurements of latitude, longitude and altitude. **Juan de Fuca plate –** The oceanic plate in the deep ocean off of southwestern British Columbia, Washington, Oregon and the northern part of California. **Juan de Fuca Ridge –** The active volcanic section of the deep ocean ridge that separates the Juan de Fuca and Pacific plates **North American plate –** One of the large continental plates that form the crust of the Earth. **Oceanic crust –** Crust on ocean floor (up to 8km. thick). Rock rich in silicon and magnesium and much more dense than continental crust. **Pacific Plate** – One of the large oceanic plates that form the crust of the Earth. **Plate tectonics –** Generally accepted theory that the Earth's crust is made up of crustal plates that "float" on an upper mantle and move more or less independently of one another. Dynamic earthquake activity is associated with the boundaries of these plates. Oceanic plates are pushed from the rear by seafloor spreading and pulled by subduction under the continental crust. **Subduction zone –**The over-lapping part of the crust where one plate (such as a dense oceanic plate) descends at an angle under another plate (such as a lighter continental plate). **Tsunamis –** Series of waves made by a major disturbance on the ocean floor such as a submarine earthquake, landslide, volcanic eruption or by impact from outer space. **Trench** – A long narrow deep area of the ocean floor where flexing oceanic plates slide

	down and under a lighter, less dense plate. **Sub-sea ridge –** An underwater divergence boundary where new plate material is pushed out as magma and cools in long fractures on the sea floor. See Juan de Fuca Ridge.

British Columbia PLO's:
Science 7
Earth and Space Science
Compare the characteristics of the Earth's core, mantle, and crust, and describe the formation of rocks
Analyse the dynamics of tectonic plate movement and landmass formation
Explain how the Earth's surface changes over time

Math 7
Represent integers in a variety of concrete, pictorial, and symbolic ways

Background:
See *OceanLink* SOLE web-pages under Dynamic Earth: Geology – Plate tectonics. See also *OceanLink* SOLE web-pages under For Teachers – Geology. The PowerPoint presentation which is downloadable, has more background information specific to British Columbia's geologic situation and pertinent to completing the worksheet.

Materials:
- Stickers, pencils and clear plastic sheet, or transparency paper for the 'see through' crust
- 1 golf pencil (or a regular short pencil) for the centre post of the GPS monument
- Student worksheet "Reading GPS Time Series Plots"
- PowerPoint Presentation on Tectonic Plates See *OceanLink* SOLE web-pages

Procedure:
Use the PowerPoint presentation for an introduction. Stop after the slide that shows what the data looks like, (the rest of the slide show is more pertinent to older students).
Follow the PowerPoint with the animations available on the OceanLink web-site (see Materials). Play the animations several times and discuss the axes, units and action. If the students do not know about the latitude and longitude coordinate system, do a brief introduction on the board, with latitude as the x-axis and longitude as the y-axis. Review basic graphing and then start the worksheet activity. Part 1 of the worksheet is very simple and helps students understand the graphing process. The use of models helps students visualize the movement of the plate (clear sheet) over the coordinate system (latitude and longitude) measured in millimeters here.
Part 1.
Step 1. Build a model of a GPS monument consisting of the sticker attached to the middle of a clear sheet with a pencil hole through the centre of the sticker
Step 2. Using the data table for Station A, plot the location of GPS Station A for each year on the graph.
Step 3. Draw an arrow with a tail at the first point; year 2003 (0,0), and an arrow at the last point; year 2008 (5,5).
Step 4. Move your sticker GPS monument from its starting position in 2003 to the end position (2008). Determine the direction the monument is moving.
Part 2.
Determine the direction monument B is moving by plotting the location each year from the data table. Determine direction and rate of motion.

Discussion:

- Discuss the graphs produced and what they are showing.
- Discuss what the sources of error might be.
- Discuss the use of technology like GPS for tracking plate movement.

Extension and Resources:

- Clague, J, C. Yorath, R. Franklin and R. Turner, 2006, At Risk: Earthquakes and Tsunamis on the West Coast. Trincouni Press
- UNAVCO http://www.unavco.org/edu_outreach/
- Animations time, strain,

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