GPlates: Next Generation Plate Tectonics Reconstruction Software

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**Global Plate Model: Continuously Closing Plate Polygons**

An idealized tectonic plate showing component margin line data features. Each line feature has its own euler pole and rotates according to the rules of plate tectonics (A). The user selects line features to create a plate polygon. GPlates automatically calculates the intersection points (red dots in B) to form the complete plate boundary. Upon each reconstruction all data rotates independently, and GPlates automatically recomputes the new closed plate boundary.

**Global Closed Plate Polygon Model:**

Using the CCP algorithms, we created global reconstructions with continuously closing plates from 140 Ma to the present. There are 45 ‘plates’ but with 485 ‘logical plate polygons’. These polygons are closures that were manually created with GPlates and embody the rules of continuous closure. The life span of a polygon is between 1 Myr and ~40 Myr. The Australian and Pacific plates are the most complex with 53 and 49 closures, respectively, and with polygons lasting on average ~3 Myr. The global average lifetime of a CCP is >5Myr. The reconstruction is available dynamically as a GPML file, which can be read in, manipulated, and output in other formats with GPlates. The data are also available as 140 sets of static polygons.

The figures show the Global Plate Polygons outlined in black; Present day Coastlines, and line features in gray. Velocity vectors are computed by plate, and colored by individual Plate ID’s (PAC=red; AUS=green, ANT=blue, etc.). The background image is a sea floor age map, with continents masked out in grey.

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**Plate Deformation: Triangulation Networks**

Our current research focuses on plate deformation. The objective is to model intra-plate deformation with a hierarchical combination of the global plate polygons, rigid blocks, and zones of plate deformation. We have introduced another topology type using Delaunay Triangulations to incorporate specific measurements of displacement and strain within constrained regional areas into the larger global model.

Upon each reconstruction each element in the topology network moves according to its own Euler Pole. The triangulation is re-computed from these new positions. The triangulation is then used to interpolate velocity values for any arbitrary point in the network’s domain. Velocity at arbitrary points outside the network are computed from the containing plate polygon. In this way we build up a hierarchy of control and constraints over crust motions.

The figure shows displacement data from: “An Animated Tectonic Reconstruction of Southwestern North America Since 36Ma” [McQuarrie & Wernicke, Geosphere, 2005]. Approximately 1000 individual polygons representing the Basin and Range elements were incorporated (white). Each centroid of the block has measured or inferred displacement values from 0Ma to 36Ma. The white arrows show these displacements as velocity vectors.

The light yellow network shows the triangulation at this age (0Ma). The black arrows show interpolated velocity values within the network. The red and gold arrows show velocity from the PAC & COC, and