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Article Title

GPlates Dataset for the Tectonic Reconstruction of the Northern An-des-Caribbean Margin

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Abstract
This contribution contains a GPlates digital reconstruction of the northern Andes and southern Caribbean margin for the last 90 Ma. It is built using different strain datasets fully described in "Continental Margin Response to Multiple Arc-Continent Collisions: the Northern Andes-Caribbean Margin" [1]. Two digital reconstructions are included here: one is a rigid block reconstruction, and the other is a continuously closing polygon reconstruction digitized every one -million years. We placed the South and North American plates at the root of the reconstruction tree, so that the Andean blocks move with respect to the former, and the Caribbean Plate, and related intra-oceanic arcs with respect to the latter. These reconstructions can be used as templates to place in palinspastic space any dataset that can be represented by lines or points.

Keywords

Keywords: Andes, Caribbean, tectonics, palinspastic reconstruction, Cenozoic, GPlates

Specifications Table

Subject	Geology
Specific subject area	Tectonics
Type of data	Plate tectonic reconstruction
How data were acquired	Digitalization of published geologic maps using off-the-shelf software (ArcMap), and freeware (QGIS).
Data format	GPlates markup language. gpml
Parameters for data collection	Faults and shear zones were digitized from published geologic maps. Most published geologic maps have a scale of 1:100.000. Geologic maps with good field control were prioritized.
Description of data collection	We combined all fault data into a single georeferenced file. This combined file was used to generate tectonic blocks bound by faults. Strain datasets were also collected for all the structures where such data exist.
Data source location	Published geologic maps.
Data accessibility	With the article
Related research article	Author's name: C. Montes, A. F. Rodriguez-Corcho, G. Bayona, N. Hoyos, S. Zapata, A. Cardona Title: Continental Margin Response to Multiple Arc-Continent Collisions: the Northern Andes-Caribbean Margin Journal: Earth Science Reviews DOI: https://doi.org/10.1016/j.earscirev.2019.102903

Value of the Data

- This digital reconstruction can be used by any researcher to place its data points in a palinspastic space for the last 65 Ma in the northern Andes and southern Caribbean margin.

- Anyone interested in the tectonics, structure and stratigraphy of the northern Andes and southern Caribbean margin and the development of mountain belts, landscape evolution

and associated biotas should benefit of this dataset as it provides a palinspastic template on which to place data.

- Since all the files are made available, the end user can make modifications, extensions, or additional elaborations using the provided dataset.

- The software to manipulate these data files is state-of-the-art and freely available, so anyone with a computer can visualize and manipulate the data.

- Tectonic reconstructions are usually provided as still images. This reconstruction lends itself for animations of the tectonic evolution of this region that can more clearly convey the timing and style of deformation.

Data

The data files consist of two tectonic reconstructions. The first reconstruction, a rigid block reconstruction (R_Recon), consists of three files (Blocks_v1.gpml, Rotations.rot, and Rigid_recon.gproj) that contain a rigid-block reconstruction of the northern Andes and southern Caribbean for the last 90 Ma. The second one, a continuously closing polygon reconstruction (CCP_Recon), consists of four .gpml files (Blocks, Auxiliary_Blocks, Auxiliary_Geometries, and Reconstruction), a project file (CCP_recon.gpml), and one rotation file (Rotations.rot), also for the last 90 Ma, but with resolved topological networks only for the last 65 Ma. All data files are in GPlates Markup Language (gpml) compressed as a supplementary file.

Experimental Design, Materials, and Methods

The database utilized for the designing and building of the reconstruction was derived from fully georeferenced published geologic maps as detailed in Table SM1 of Montes et al [1]. Intersections of major faults defined 108 tectonic blocks for the northern Andes and the southern Caribbean. Because of the flexibility allowed by the topological closing of polygons, the 108 rigid blocks are represented in the continuously closing polygon reconstruction by a smaller number of tectonic blocks (54).

Both reconstructions (rigid and continuously closing) can be used to place custom files (points, lines or polygons) on top of the reconstruction to study their palinspastic location. The rigid reconstruction can be used to place points in palinspastic space strictly following the rigid blocks, so there is no distortion for the last 90 Ma. However, since the rigid block reconstruction at 0 Ma contains gaps (representing extension), and overlaps (representing shortening), not all points may get assigned a block ID (gaps), or may get more than one (overlaps). The continuously closing polygon reconstruction instead, has no gaps or overlaps, but the custom data will be distorted following the deforming closing polygons, and it only covers the last 65 Ma. Users of the continuously closing polygon reconstruction must also be warned that observation has to be done in the same, one million-year intervals starting at zero, as the software does not interpolate between the established one-million-year intervals. The rigid reconstruction, in contrast interpolates between user-defined times in the rotation file and observation can be performed at

any point in time. For display purposes we suggest using the South American Plate as the reference plate (plate number 201).

The polygons in the CCP reconstruction change their size, area and geometry, so that they can be deformed (stretched/shortened) in geologic time [2]. The continuously closing polygons can be used to generate topological networks, which may be used to consider the internal deformation of the blocks. A topological network is constructed by making a Delaunay triangulation between tectonic block boundaries (split in points) and inner points which describe their internal deformation, creating a triangular mesh. Topological networks can therefore be used to create a deformation field over the surface of the tectonic blocks, and restore the position of vector layers (except polygons) to a hypothetical pre-deformed state. Reconstruction results can be exported from Gplates as an ESRI shapefile at user-defined time intervals.

In the following paragraphs we provide a simple set of steps for any end-user to interact with the reconstructions by restoring the paleo latitude/longitude of localities of interest between 65-0 Ma. First, however, the data of interest need to be converted to ESRI shape vector files where each geometry has to have the plate ID of the block where it belongs at present time (0 Ma). You can do this by first exporting the 0 Ma snapshot of the CCP reconstruction into a shape file. This shape file contains a column named "PLATEID1" where the program stores the name of each plate. To do this, open the continuously closing polygon reconstruction folder (CCP_recon) and make sure all four gpml files and the rotation file are located within the same directory as the project file (CCP_recon.prj). Open the project file with GPlates 2.0 or newer. Once opened, choose "Export" under the Reconstruction menu, and in the pop-up window choose "Add Export", and choose "Resolved Topologies (general)". Export a single snapshot at 0 Ma in shape file format making sure to choose to option to export to a single file and "Export resolved topological polygons". This operation will create a version of the polygons at 0 Ma in a shape files with all of the plate ID names under the column called "PLATEID1". Use your GIS program of preference to add the identity (PLATEID) of each one of your geometries to your dataset.

Open the continuously closing polygon reconstruction folder (CCP_recon). GPlates should automatically open the Layers window where the files should be loaded, including the rotation file, the auxiliary blocks and geometries, and three layers of the reconstruction: the Resolved Topological Geometries (visible), the Resolved Topological Networks (hidden), and the Reconstructed geometries (hidden). At this point it is convenient to set the reconstruction parameters by going to the Reconstruction menu and choosing "Configure animation". Choose a 90 Ma or younger starting point, as the reconstruction only covers this interval of time. Also, under the same menu, you may choose the South American Plate (201) as the anchored plate.

Now, you can load your shape file by going to the File menu and choosing "Open Feature Collection", where you locate your shape file(s). When loading for the first time, a pop-up window will ask for the column that contains the plate ID of your dataset. Once loaded, look for your data in the Layers window, and expand it by clicking in the black arrow located to the left of the file name, and choose "Add new connection" in the "Topology Surfaces" option. Add the two closed dynamic polygon layers of the reconstruction (pink and light brown "Reconstruction" layers). Then, in the same window, select "Reconstruct using topologies" box (just click on "Yes"). A win-

dow will be automatically pop-up where you set the youngest age to 0 Ma, and the oldest Age to 65 Ma. Then, you need to set the desired time increment, being careful not to use a frequency higher than the one used to generate the dynamic polygons (1 Ma). Leave all the other options as they are. Click OK, and after a few seconds you can click on the play button of the main window to show your localities in palinspastic space.

Now that you have your dataset moving along the the continuously closing polygons you can export it as shapefiles for custom time intervals, just use "Export Time Sequence of Snapshots". This way, any dataset that can be represented by points, or lines may be placed on top of one of the palinspastic reconstructions to study its hypothetical palinspastic location. These may include fossil localities, stratigraphic sections, geochronological/thermochronological sample locations, boreholes, geological cross-sections, fault lines, population boundaries, etc.

Acknowledgments

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