



PyGPlates – a GPlates Python library for data analysis through space and deep geological time

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A fundamental consideration for studying the Earth through deep time is that the configurations of the continents, tectonic plates, and plate boundaries are continuously changing. Within a diverse range of fields including geodynamics, paleoclimate, and paleobiology, the importance of considering geodata in their reconstructed context across previous cycles of supercontinent aggregation, dispersal and ocean basin evolution is widely recognised. Open-source software tools such as GPlates provide paleo-geographic information systems for geoscientists to combine a wide variety of geodata and examine them within tectonic reconstructions through time. The availability of such powerful tools also brings new challenges – we want to learn something about the key associations between reconstructed plate motions and the geological record, but the high-dimensional parameter space is difficult for a human being to visually comprehend and quantify these associations. To achieve true spatio-temporal data-mining, new tools are needed.

Here, we present a further development of the GPlates ecosystem - a Python-based tool for geotectonic analysis. In contrast to existing GPlates tools that are built around a graphical user interface (GUI) and interactive visualisation, pyGPlates offers a programming interface for the automation of quantitative plate tectonic analysis or arbitrary complexity. The vast array of open-source Python-based tools for data-mining, statistics and machine learning can now be linked to pyGPlates, allowing spatial data to be seamlessly analysed in space and geological “deep time”, and with the ability to spread large computations across multiple processors. The presentation will illustrate a range of example applications, both simple and advanced. Basic examples include data querying, filtering, and reconstruction, and file-format conversions. For the innovative study of plate kinematics, pyGPlates has been used to explore the relationships between absolute plate motions, subduction zone kinematics, and mid-ocean ridge migration and orientation through deep time; to investigate the systematics of continental rift velocity evolution during Pangea breakup; and to make connections between kinematics of the Andean subduction zone and ore deposit formation. To support the numerical modelling community, pyGPlates facilitates the connection between tectonic surface boundary conditions contained within plate tectonic reconstructions (plate boundary configurations and plate velocities) and simulations such as thermo-mechanical models of lithospheric deformation and mantle convection. To support the development of web-based applications that can serve the wider geoscience community, we will demonstrate how pyGPlates can be combined with other open-source tools to serve alternative reconstructions together with a diverse array of reconstructed data sets in a self-consistent framework over the internet. PyGPlates is available to the public via the GPlates web site and contains comprehensive documentation covering installation on Windows/Mac/Linux platforms, sample code, tutorials and a detailed reference of pyGPlates functions and classes.