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The GPlates Geological Information Model and Markup Language

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Understanding geodynamic processes leading to the present-day configuration of the Earth involves studying data and models across a variety of disciplines, from geochemistry, geochronology and geophysics, to plate kinematics and mantle dynamics. All these data exist within a 3-dimensional spatial and 1-dimensional temporal framework, a formalism which is not exploited by traditional spatial analysis tools. This is arguably a fundamental limit in both the rigour and sophistication in which datasets can be combined for "deep time" analysis, and confines the extent of analyses to smaller datasets where statistical confidence is hard to ascertain. The GPlates Geological Information Model (GPGIM) represents a formal specification of geological and geophysical data in a time-varying plate tectonics context, used by the GPlates virtual-globe software. It provides a framework in which relevant types of geological data are attached to a common plate tectonic reference frame, allowing spatio-temporal plate motions to be reconstructed coherently. The GPlates Markup Language (GPML), being an extension of the open standard Geography Markup Language (GML), is both the modelling language for the GPGIM and an XML-based data format for the interoperable storage and exchange of data modelled by it. The GPlates software implements the GPGIM allowing researchers to query, visualise, reconstruct and analyse a rich set of geological data including numerical raster data. The GPGIM has recently been extended to support time-dependent geo-referenced numerical raster data by wrapping GML primitives into the time-dependent framework of the GPGIM. Coupled with GPlates' ability to reconstruct numerical raster data and import/export from/to a variety of raster file formats, this takes interoperability with geodynamic softwares to a new level as well as enabling a new generation of deep-time spatio-temporal data analysis and exchange, including a variety of new functionalities such as 4D data-mining.