Interactive GSSP Map

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Contents

1 Overview

This *Interactive GSSP Application* is the result of a 10 week Research Experience Undergraduate internship. The internship focused on time ontology, RDF databases, and designing applications in R. This document provides an outline for the user interface and server of this application, which is based on the Deep Time Knowledge Base.

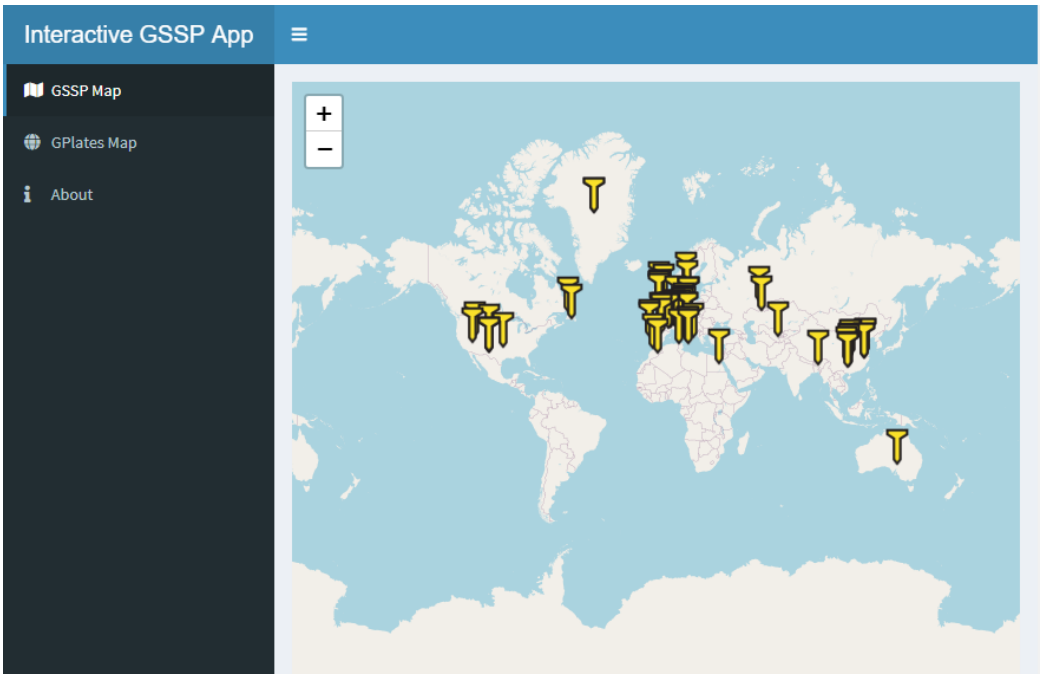
This application has two main pages, as well as a page with additional information about the app. The first page is the GSSP Marker Map. Users can visit each stratotype point on the map and read information about them. The second page is the GPlates Reconstruction Map. This page uses the GPlates API to reconstruct the coastlines of Earth and calculate each stratotype point's paleo-geographic coordinates.

2 GSSP Marker Map

Global Boundary Stratotype Section and Points (GSSP) define the lower bounds of geological time concepts. In this interactive map users can view all the GSSPs from the most recent international scheme. Users can click on each marker to learn more about the corresponding GSSP at the marker's location.

2.1 User Interface & Workflow

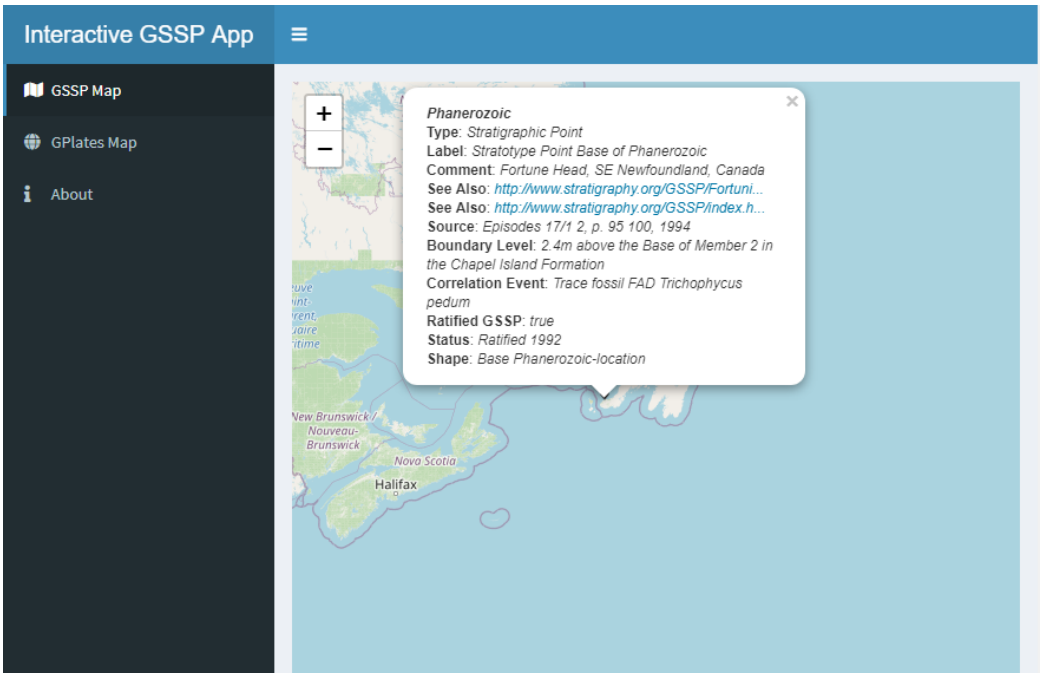
Upon opening the app the user is presented with a map of Earth. The user can zoom in and out by clicking the '+' and '-' icons. The user can also zoom in and out by scrolling the mouse scroll wheel up and down when the mouse is hovering over the map. To navigate around the map simply click and drag the map with the mouse.



(a) The first screen on opening

There are markers placed on the map. Each marker is placed at a golden spike's location. The markers can be clicked on and a popup window will

appear with some information about the corresponding GSSP. These can be minimized by clicking the 'X' in the top right corner of the popup window or just by clicking outside of the window.



(b) The popup window for the Phanerozoic GSSP

Each popup window displays some information available for its GSSP. This information is gathered from the Deep Time Knowledge Base. The name of the GSSP is the first item; it is bold and italicized. Each line afterwards contains a predicate (bold) followed by a property (italicized). Several properties are hyperlinks; these properties are a blue color and will be underlined when the mouse is hovering over them. Clicking on these will open a new tab in the user's browser where the user can read more about the GSSP. Please note that some of these links are broken. When these links where added to the Deep Time Knowledge Base they were functional but some websites have been removed or moved to different addresses.

2.2 Server

The server-side of this window is rather straightforward. The server sends SPARQL queries to collect data. The data is then processed and used to

construct an interactive map. There is no user input to process.

The first SPARQL query finds the most recent international scheme. The second query finds all GSSPs in the most recent international scheme, as well as all of its properties. This information is queried from the Deep Time Knowledge Base.

label	coordinates	pred	prop
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://resource.geosciml.org/ontology/timescale/gts#StratigraphicPoint
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://www.w3.org/2000/01/rdf-schema#label	Stratotype Point Base of Hauterivian
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://www.w3.org/2000/01/rdf-schema#seeAlso	http://cretaceous.stratigraphy.org/gssps/gssp-hauterivian-stage
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://www.w3.org/2000/01/rdf-schema#seeAlso	http://www.stratigraphy.org/GSSP/index.html
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://resource.geosciml.org/ontology/timescale/gts#boundaryLevel	base of bed number 189
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://resource.geosciml.org/ontology/timescale/gts#correlationEvent	The FO of the ammonite genus Acanthodiscus and the top of Chron M10Nn.3n coincides with the base of the Hauterivian.
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://resource.geosciml.org/ontology/timescale/gts#ratifiedGSSP	TRUE
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://resource.geosciml.org/ontology/timescale/gts#status	Ratified 2019
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	http://def.seegrid.csiro.au/ontology/om/sam-lite#shape	http://resource.geosciml.org/classifier/ics/ischart/BaseHauterivian-location
Stratotype Point Base of Priabonian	POINT(11.91802 45.91419)	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://resource.geosciml.org/ontology/timescale/gts#StratigraphicPoint
...	...	...	...

(c) The query results before processing

The information gathered is not incredibly readable or easy to construct a map with. The longitude and latitude should be more easily accessible. There should be only one marker and popup window per GSSP. The popup window should contain easily readable text or hyperlinks, not unnecessarily long URIs. In order to accomodate all this the dataframe is processed. Predicate URIs are shortened. Property URIs are either shortened or turned into hyperlinks. After some URIs are shortened they are processed further by adding spaces and capitalization. Since most URIs end with terms in camel case this is done with regular expressions. The popup window will display HTML, so some minor formatting can be done with HTML tags (line breaks, hyperlinks, bolding, and italicizing).

label	coordinates	text
Hauterivian	5.443722 44.46944	***Hauterivian***
		Type: *Stratigraphic Point*
		Label: *Stratotype Point Base of Hauterivian*
		See Also: *http://cretaceous.stratigraphy.org/gssps/gssp-hauterivian-stage*
		See Also: *http://www.stratigraphy.org/GSSP/index.html*
		Boundary Level: *base of bed number 189*
		Correlation Event: *The FO of the ammonite genus Acanthodiscus and the top of Chron M10Nn.3n coincides with the base of the Hauterivian.*
		Ratified GSSP: *true*
		Status: *Ratified 2019*
		Shape: *Base Hauterivian-location*
Priabonian	11.91802 45.91419	***Priabonian***
		Type: *Stratigraphic Point*
...	...	...

(d) The query results after processing

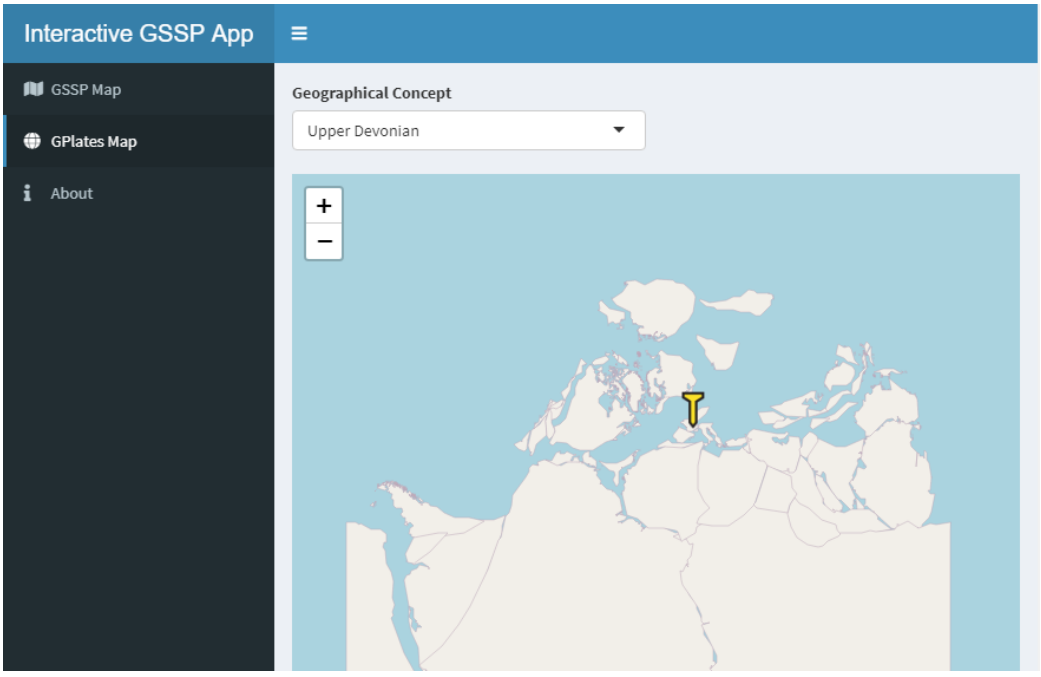
The map is then constructed from the processed dataframe using the Leaflet package. Markers are placed at each GSSP's location with a golden spike icon. The markers display the HTML text in a popup window after clicking on them.

3 GPlates Reconstruction Map

Each Global Boundary Stratotype Section and Point (GSSP) defines a lower bound of a geological time concept. This window of the application uses the GPlates Web Service to construct a map of Earth at the selected GSSP's lower bound. The GSSP's position at that lower bound is plotted as well. Users can select GSSPs from a drop-down menu.

3.1 User Interface & Workflow

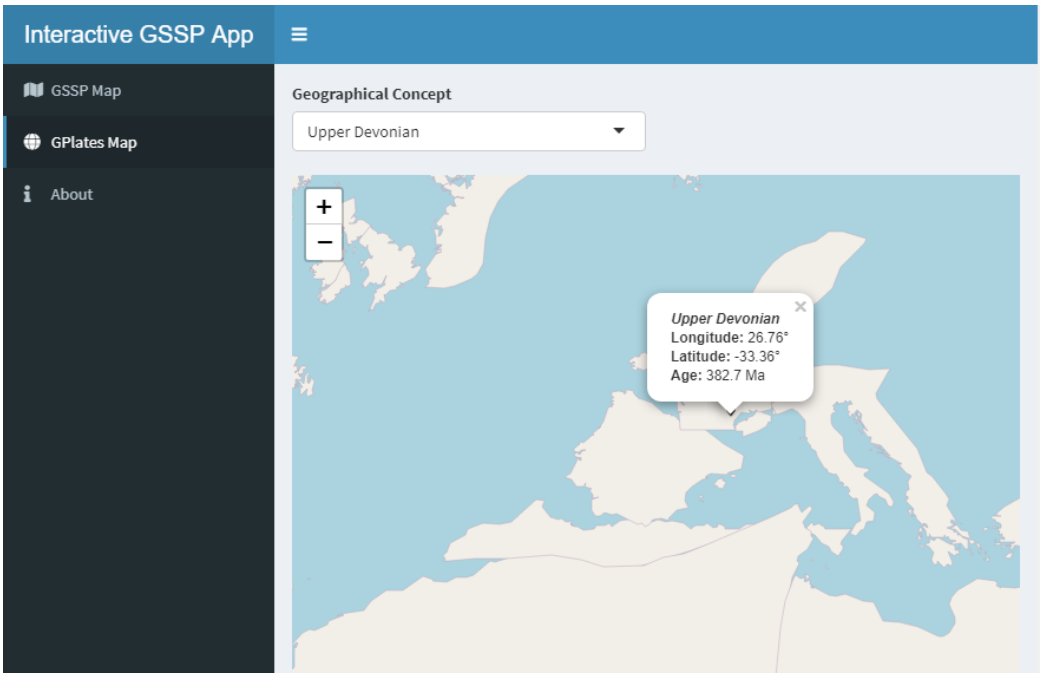
To view a map of Earth at a GSSP's lower bound the user must select the GSSP from the drop-down menu. The entries in the drop-down menu are sorted by age (ascending). Once the GSSP is selected the map will be constructed. This may take several seconds; the data that is read to reconstruct the coastlines is quite large. The controls to interact with the map are the same as the GSSP Marker Map.



(e) Example reconstructed map

Clicking on the marker will open a popup window with the GSSP's longitude and latitude at its lower bound in time as well as the lower bound (in

mega annum) itself.



(f) Example popup window

3.2 Server

Before the user makes a selection, several SPARQL queries are run in order to compile a list of GSSPs the user can select from. The first SPARQL query finds the most recent international scheme. All GSSPs from that scheme are retrieved from another SPARQL query, as well as their coordinates and lower bounds. The resulting dataframe is processed into a more functional dataframe. All information is retrieved from the Deep Time Knowledge Base.

label	coordinates	timeValue
Stratotype Point Base of Hauterivian	POINT(5.443722 44.46944)	132.6
Stratotype Point Base of Priabonian	POINT(11.91802 45.91419)	37.71
...	...	...

(g) Dataframe before processing

concept	longitude	latitude	time
Hauterivian	5.443722	44.46944	132.6
Priabonian	11.91802	45.91419	37.71
...	...	...	...

(h) Dataframe after processing

After the user makes a selection from the drop-down menu the map is reloaded. This involves reading JSON from GPlates servers and plotting the JSON in a Leaflet map.

There are two aspects to this reconstructed map: reconstructing coastlines and calculating paleo-geographic coordinates. Reconstructed coastlines requires one argument, time in Ma, and has several optional arguments, one of which being a reconstruction model. Calculating the coordinates requires the present-day coordinates and time in Ma and has several optional arguments, one of which is also the reconstruction model. The GSSP's lower bound was used as the argument for time in Ma and its present-day coordinates were used to calculate its paleo-geographic coordinates. The models used depends on the lower bound of the GSSP. Models only support specific ranges of time.

After the URLs are constructed the JSON is read from the GPlates websites. The coastline JSON is used to create the Leaflet map. The coordinate JSON is parsed and then used to add a marker on the Leaflet map. This marker has a popup window with all of the information retrieved from the initial SPARQL queries.

4 Tools Used

4.1 Databases & Web Services

- Deep Time Knowledge Base
- GPlates Web Service

4.2 R Packages

- Leaflet for R
- Shiny & Shiny Dashboard
- SPARQL

5 Source Code & Contact

The source code is available here. If you have any questions you can reach me at christophermcv@outlook.com.