

Plotting Palaeogeographical Maps in R: an Example

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Palaeogeographical Maps

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- ▶ Deep Time Maps (<https://deeptimemaps.com>)
- ▶ Paleomap Project (<http://scotese.com>)

GPlates (<https://www.gplates.org/>) reconstructs palaeogeography at arbitrary time.

Automatic map plotting

- ▶ NonaR/paleoMap (<https://github.com/NonaR/paleoMap>)

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- ▶ NonaR/paleoMap (<https://github.com/NonaR/paleoMap>)
- ▶ LunaSare/gplatesr (<https://github.com/LunaSare/gplatesr>)

GPlates Web Service

► <https://gws.gplates.org/>

```
coastline_gws_url <-  
  "http://gws.gplates.org/reconstruct/coastlines/?time=1558  
polygons_gws_url <-  
  "http://gws.gplates.org/reconstruct/static_polygons/?time  
  
kimmeridgian_coastlines <-  
  rgdal::readOGR(coastline_gws_url) %>%  
    broom::tidy()  
kimmeridgian_polygons <-  
  rgdal::readOGR(polygons_gws_url) %>%  
    broom::tidy()
```

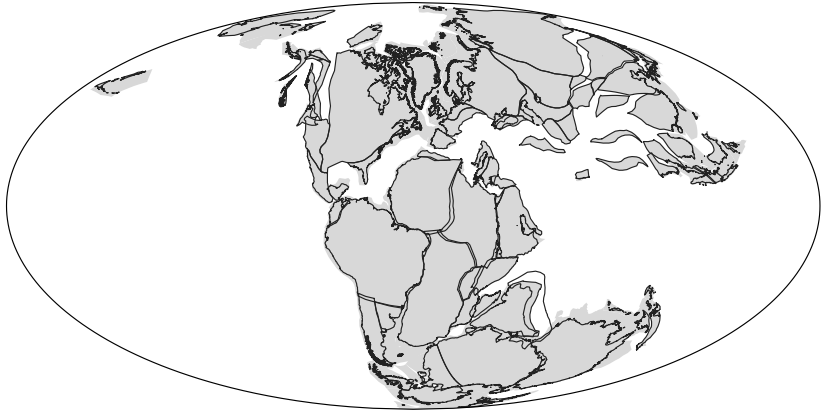



Figure 1: **Outlines of continental plates in the Kimmeridgian (155 Ma).** Data downloaded from the GPlates web service.

'True' Palaeogeographical Outlines

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GPlates web service gives:

- ▶ outlines of plates from the model
- ▶ modern coastline outlines
- ▶ I want *ancient coastal outlines* instead

- ▶ GPlates software has more models
- ▶ Including Cao et al. (2017) palaeogeographical reconstructions

```
map_layers <-  
  c(  
    "Land"           = "#FFD23A",  
    "Mountain"       = "#FF8D51",  
    "Shallow marine" = "#45D8FF"  
  )
```

Method

1. Load data into GPlates
2. Export for desired
3. Load into R and plot

But showing the separate layers (land, mountain, shallow marine, ice) doesn't work easily with `geom_map`.

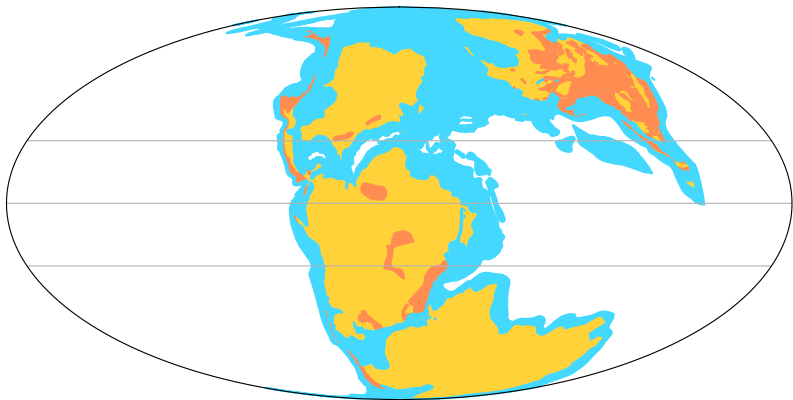
- ▶ have to add a new geom for every layer:

```
ggplot() +  
  geom_map() +  
  geom_map() +  
  geom_map() + ...
```

Instead I assign names to the layers (land, mountain...) and use `geom_polygon` to plot.

NB:

- ▶ The data has 'groups' and 'subgroups' to close off the polygons, otherwise shapes may cross the whole globe.
- ▶ Layers must be plot in order be marine > land > mountain > ice – use factors.

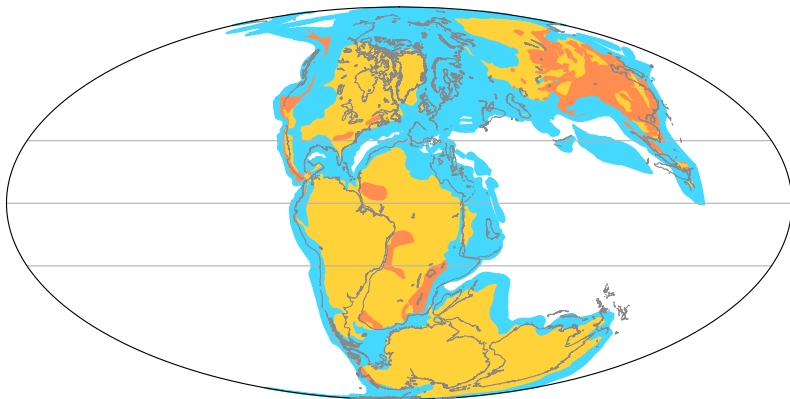


Palaeogeography  Land  Mountain  Shallow marine

Figure 2: **Palaeogeography in the Kimmeridgian (155 Ma).**

I also wanted to add coastlines to show where modern countries are, but not the full plates from the web service.

- ▶ use coastlines reconstructed polylines



Palaeogeography

	Land		Mountain		Shallow marine
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Figure 3: **Palaeogeography in the Kimmeridgian (155 Ma).** Outlines of modern coastlines (where known) are included in grey.

Add Fossil Occurrences

Now to add some fossil occurrences.

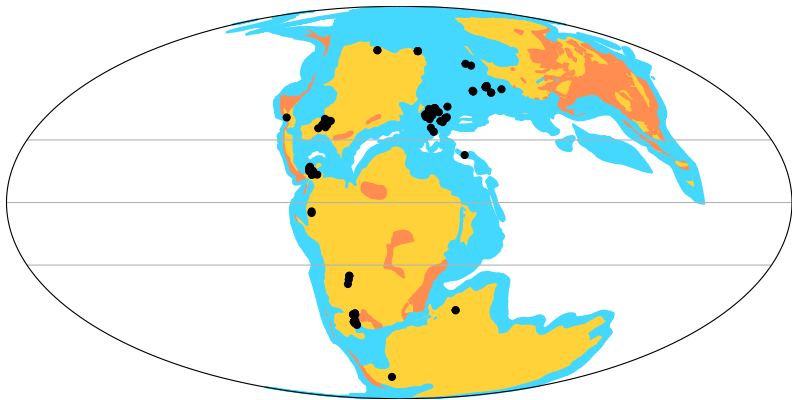
Of course it's ichthyosaurs, because I have no imagination:

- ▶ Callovian–Tithonian (166-145 Ma)
- ▶ all levels, taxonomy – no filtering

```
pbdb_url <-  
  "https://paleobiodb.org/data1.2/occs/list.csv?base_name="
```

```
occ_ichthyosaurs <-  
  read_csv(pbdb_url)
```

Use `geom_point` to overlay this on the base map.



Palaeogeography  Land  Mountain  Shallow marine

Figure 4: **Occurrences of ichthyosaurs from the Callovian–Tithonian.** Palaeogeographical map shows the distribution of land in the Kimmeridgian (155 Ma).

These plots can also be split automatically using *facets*.

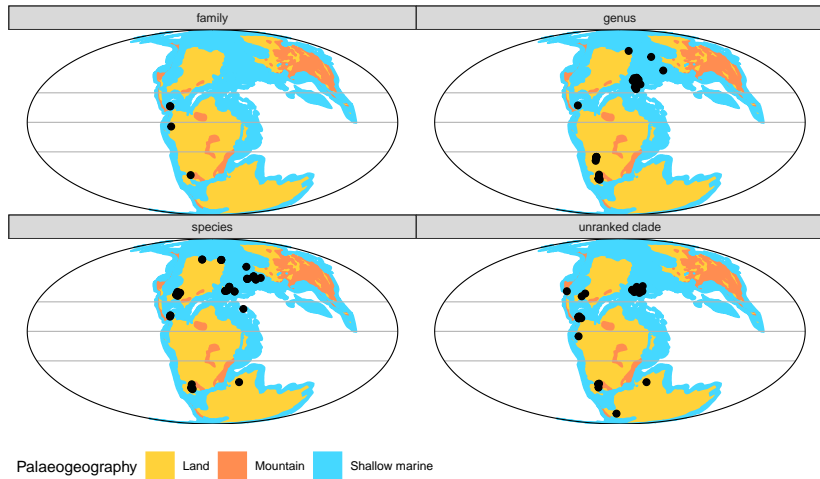


Figure 5: **Occurrences of ichthyosaurs in the Callovian–Tithonia separated by identified rank.** Palaeogeographical maps shows distribution of land in the Kimmeridgian (155 Ma).