GBRCD Example R Code for LiPD version

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R Markdown document with example code for handling GBRCD LiPD

This document contains examples for how users can process, subset and visualise the GBRCD. The example demonstrates handling LiPD data and filtering the data by proxy, age and location. The example demonstrates how to produce two types of figures; line plots for visualising the record data and maps for visualising locations.

```
## Load required packages ##

# To work with LiPD format files
library(lipdR)
# For plotting
library(geoChronR)
# Tidyverse includes dplyr (for data frame manipulation),
# lubridate (for handling dates) & ggplot2 (for plotting)
library(tidyverse)
```

Load LiPD files

Example of loading GBRCD data from lipdverse (v1_0_0 is the current version as of February 2024). Check https://lipdverse.org/GBRCD/current_version/ for updates.

Alternatively, data can be loaded from a local copy of the GBRCD.

```
# Load data from lipdverse
gbrcd_lipd <- readLipd('https://lipdverse.org/GBRCD/current_version/GBRCD1_0_0.zip')

# Alternatively load the GBRCD from a local copy of the data.
  # Unzip the GBRCD zip file (i.e. GBRCD1_0_0.zip) before running the code.
  # Select 'd' to load directory at the prompt, and select any file within the unzipped folder.

# gbrcd_lipd <- readLipd()
# OR
# gbrcd_lipd <- <- readLipd(path = "")
```

Show metadata

Check metadata of the first and last datasets in the LiPD database.

```
# Use to view first dataset
head(gbrcd_lipd, 1)
```

$AL03DAV01_1 ##
AL03DAV01_1 AL03DAV01_1 v.1.0.0 ##

Archive Type

Coral

Geographic Metadata

Davies Reef (-18.8N, 147.7E), -3.1 masl

Publications (printing first 2 citations of 2 total)

Alibert, C., Kinsley, L., Fallon, S.J., McCulloch, M.T., Berkelmans, R. & McAllister, F. (2003), 'Source of trace element variability in Great Barrier Reef corals affected by the Burdekin flood plumes', Geochimica et Cosmochimica Acta, 67 (2), 231-246, 10.1016/S0016-7037(02)01055-4.

Alibert, C. & McCulloch, M.T. (1997), 'Strontium/calcium ratios in modern Porites corals From the Great Barrier Reef as a proxy for sea surface temperature: Calibration of the thermometer and monitoring of ENSO', Paleoceanography, 12 (3), 345-363, 10.1029/97PA00318.

Paleo Data

Summary data for object 1, Measurement Table 1 of 1: Measurement table contains 215 observations of 3 variables

```
# Use to view last dataset
tail(gbrcd_lipd, 1)
```

$XI20ARL01 ##
XI20ARL01 XI20ARL01 v.1.0.0 ###

Archive Type

Coral

Geographic Metadata

Arlington Reef (-16.6381N, 146.1036E), -4 masl

Publications (printing first 1 citations of 1 total)

Xiao, H., Deng, W., Wei, G., Chen, J., Zheng, X., Shi, T., Chen, X., Wang, C., Liu, X. & Zeng, T. (2020), 'A Pilot Study on Zinc Isotopic Compositions in Shallow-Water Coral Skeletons', Geochemistry, Geophysics, Geosystems, 21 (11), e2020GC009430, 10.1029/2020GC009430

Paleo Data

Summary data for object 1, Measurement Table 1 of 1: Measurement table contains 52 observations of 6 variables

Convert the LiPD object

Convert the multi-LiPD object into a LiPD time series object (TS) for manipulation and filtering.

Includes an example of a summary of GBRCD data (spatial and temporal coverage)

```r
# Extract multi-LiPD object (GBRCD directory) to a TS object
gbrcd_TS <- extractTs(gbrcd_lipd)

# Display summary plot
  # No colour options can currently be applied
gbrcd_summ <- plotSummaryTs(gbrcd_TS,
                    sort.var = "archiveType",
                    age.var = "year",
                    lat.range = c(-11.5, -24),
                    lon.range = c(142.5, 153),
                    size = 2)
```
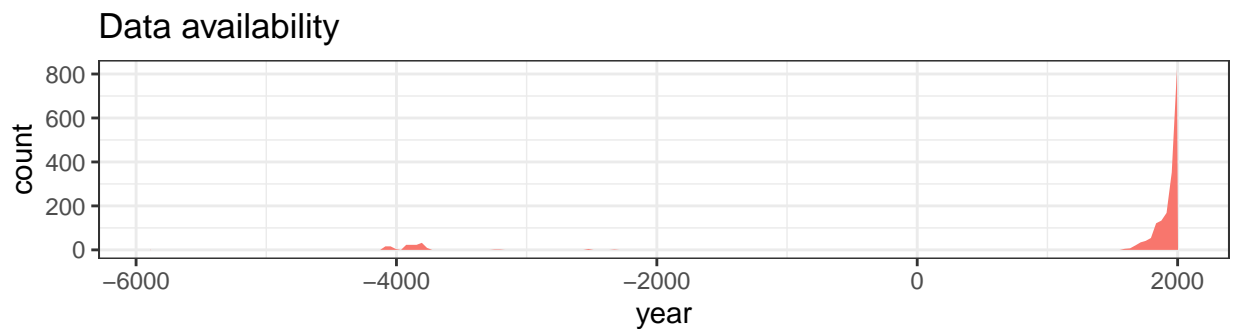
Filter datasets by proxies, location, resolution, etc.

An example for how to subset/filter by properties.

Ba/Ca is used as an example variable to filter the GBRCD

Suggested fields for filtering:

- Record coverage (note this is number of years of data and accounts for gaps):
  - paleoData_gbrDataCoverageGroup (1 = >100 years, 2 = 10-100 years & 3 = <10 years of data)
- Temporal Coverage (note this is total temporal span of records):
  - minYear (record start year)
  - maxYear (record end year)
- Record Resolution:
  - paleoData_samplingResolution (nominal resolution)
- Location:
  - geo_latitude (record latitude; degrees N (all GBR latitudes are negative))
  - geo_longitude (record longitude; degrees E (all GBR longitudes are positive))
  - geo_siteName (name of the site/reef)
- Species:
  - paleoData_sensorSpecies (coral genus and species (if known))
- Record Method:
  - paleoData_measurementMethod (method used for record measurement)
- SST Calibration:
  - gbrIsSstCalibration (record is SST calibration dataset (SrCa, UCa, d18O); T/F)
 - gbrUseSstCalibration (record uses SST calibration (SrCa, UCa, d18O); T/F)

** All metadata fields may be be used for filtering, but the above list above includes the suggested starting point for investigating the data.

```r
# We can convert the lipd-TS to a tibble to filter the database even more efficiently:
gbrcd_tib <- ts2tibble(gbrcd_TS)

# Filter for proxy of choice e.g. Ba/Ca
gbrcd_baca_tib<- gbrcd_tib %>%
  filter(paleoData_variableName == "BaCa")

# Convert to TS
gbrcd_baca_Ts <- as.lipdTs(gbrcd_baca_tib)


# Plot map of Ba/Ca records in the GBRCD
  # No colour options (except black) can currently be applied
mapTs(gbrcd_baca_Ts,
      lat.range = c(-11.5, -24),
      lon.range = c(142.5, 153),
      color = "paleoData_variableName",
      size = 2)
```
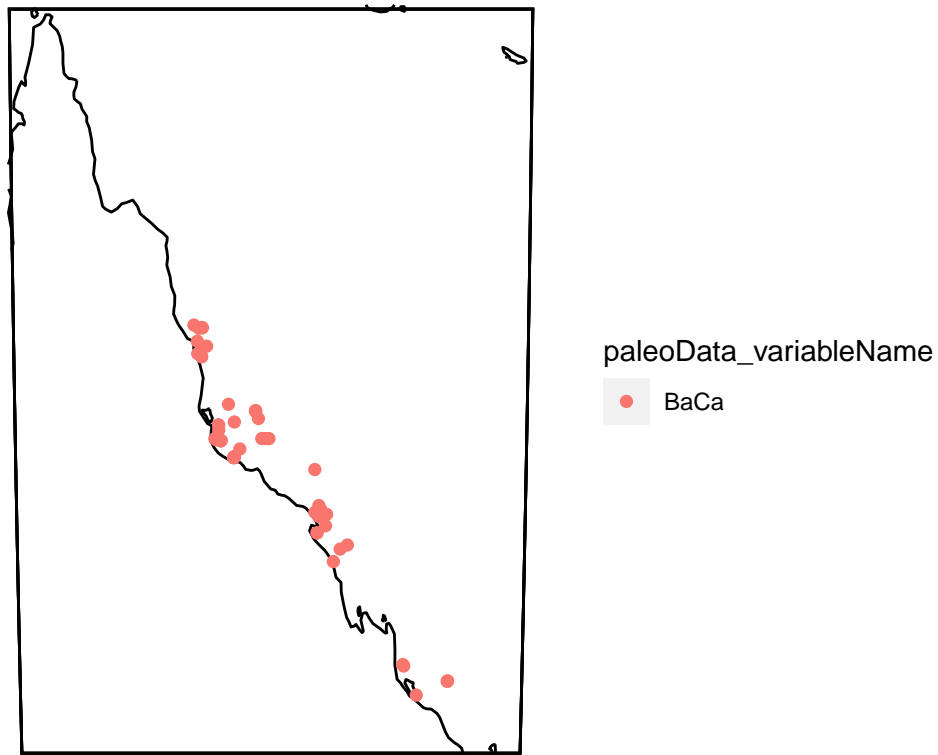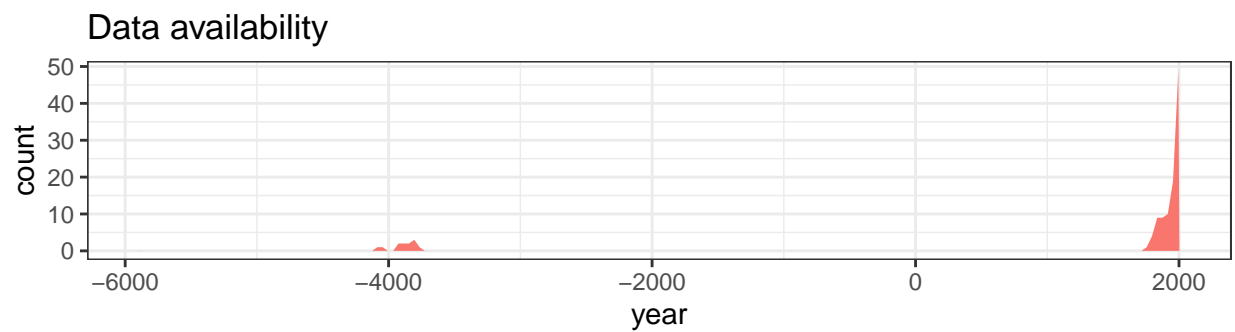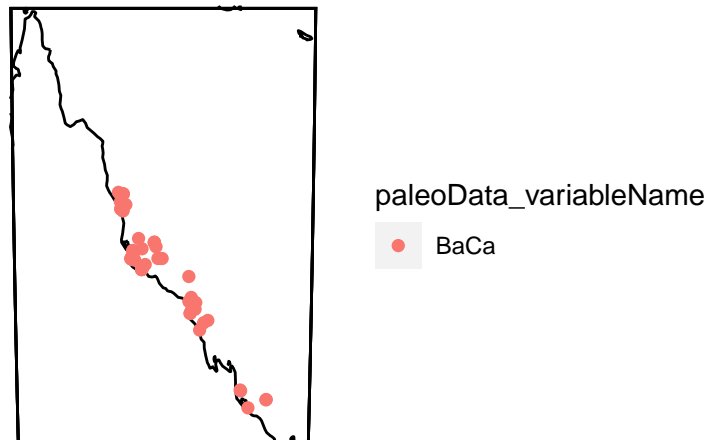
```
# Plot summary of Ba/Ca records in the GBRCD
# Returns map and temporal coverage of data
  # No colour options can currently be applied
BaCaSumm <- plotSummaryTs(gbrcd_baca_Ts,
                          sort.var = "paleoData_variableName",
                          age.var = "year",
                          lat.range = c(-11.5, -24),
                          lon.range = c(142.5, 153),
                          size = 2 )
```

Select a single record for summary

Any single LiPD file/dataset can be selected and a summary of relevant data produced

```r
# Plot a dashboard summarizing Ba/Ca of an individual record in the database
plotSummary(gbrcd_lipd[[125]],
            paleo.age.var = "year",
            paleo.data.var = "BaCa")
```

```
## [1] "Found it! Moving on..."
## [1] "Found it! Moving on..."
```

```
DataSetName: LE19RUS02
Archive Type: Coral
Citation: Leonard, N.D., Welsh, K.J., Nguyen, A.D., Sadler, J.,
          J.M., Clark, T.R., Zhao, J.x., Feng, Y.x. & Webb, G.E
          'High resolution geochemical analysis of massive Pori
          corals from the Wet Tropics, Great Barrier Reef: rare
          elements, yttrium and barium as indicators of terrige
          Marine Pollution Bulletin, 149, 110634,
          10.1016/j.marpolbul.2019.110634.
```
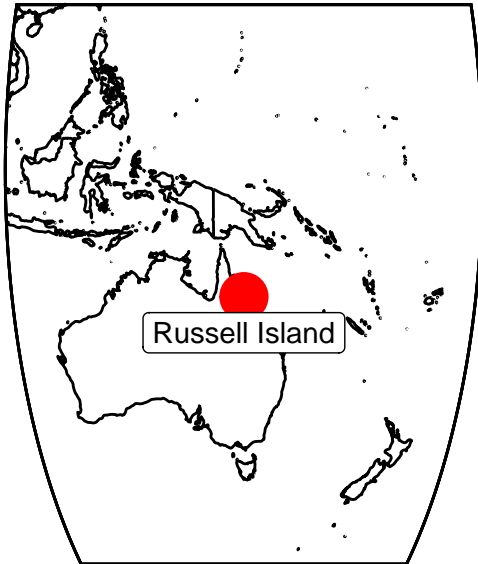
PaleoData: BaCa
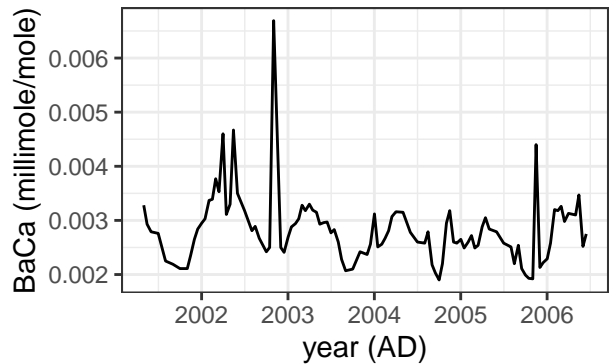
No chronData

```
## TableGrob (4 x 4) "arrange": 4 grobs
##   z    cells    name                grob
## 1 1 (1-1,1-2) arrange gTree[GRID.gTree.254]
## 2 2 (1-2,3-4) arrange        gtable[layout]
## 3 3 (2-4,1-2) arrange        gtable[layout]
## 4 4 (3-4,3-4) arrange gTree[GRID.gTree.251]
```

Plot GBRCD Ba/Ca

Prepare and plot LiPD data time series stack of 'modern' Ba/Ca data in the GBR south of 22.5 S ($<$ -22.5)

```r
# Create long tibble and filter data
gbrcd_baca_longTib <- as.lipdTsTibbleLong(gbrcd_baca_Ts) %>%
  # Filter for ages after 1950 and latitudes south of 22.5 S
  filter(year > 1950 & geo_latitude < -22.5) %>%
  # Filter max Ba/Ca values
  filter(paleoData_values <= 0.025) %>%
  arrange(desc(dataSetName))
```
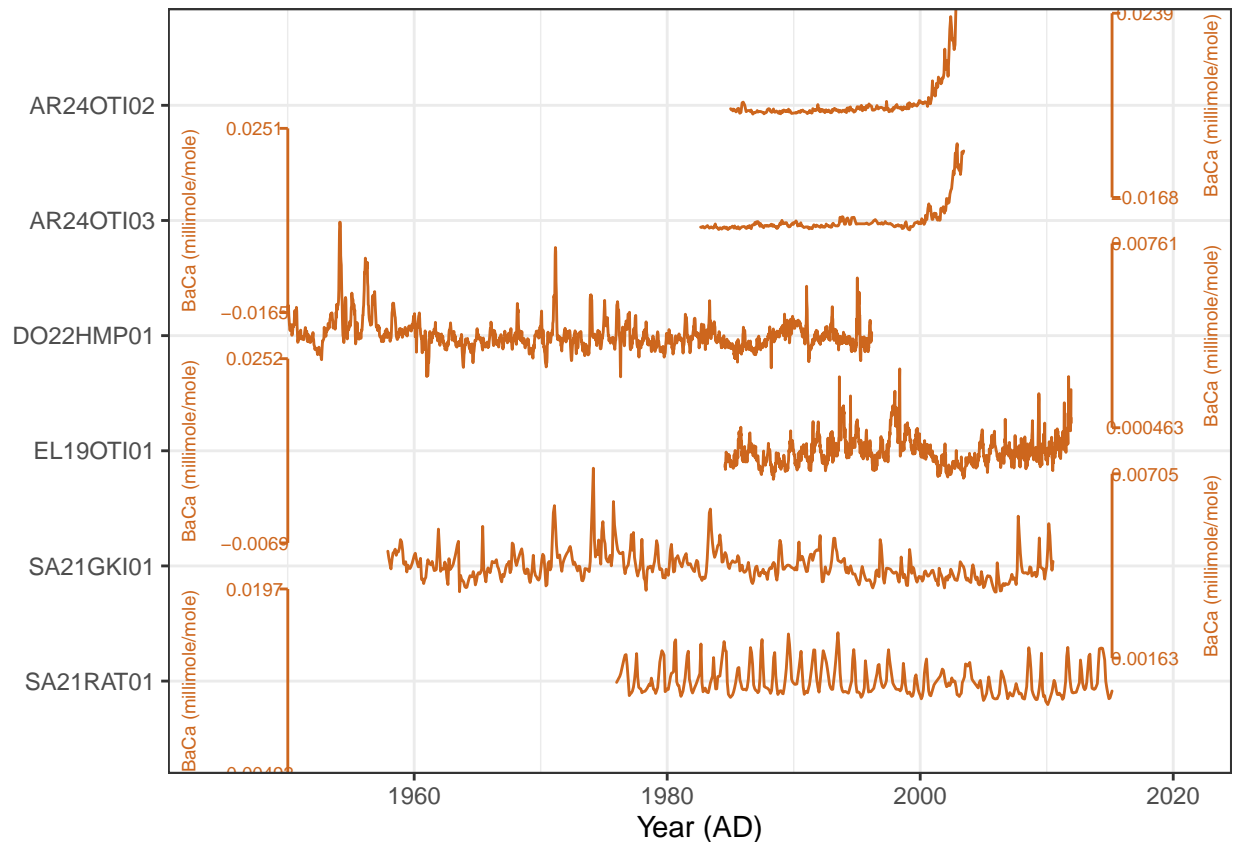
```
## creating a lipd_Ts_Tibble_Long using year as the age.var
```

```r
# Plot a time series stack from the filtered data
plotTimeseriesStack(gbrcd_baca_longTib,
    color.var = "paleoData_variableName",
```

```
    color.ramp = "#CD661D",
    lab.size = 2.5,
    fill.alpha = 0,
    lab.space = 3,
    lab.buff = 0.04,
    scale.factor = 1/8,
    scale.height = 0.8)
```


Alternate plotting LiPD as tidy TS

Prepare and plot LiPD data for 'modern' (post 1700 CE) Ba/Ca data (entire GBR, southern GBR (i.e. south of 20 S) and southern GBR south of -22.5 since 1950)

```
# Create tidy TS object and filter for data from 1500s-present
gbrcd_baca_tidy <- tidyTs(gbrcd_baca_Ts) %>%
  filter( year > 1700)



# Plot all Ba/Ca records for entire GBR
ggplot(gbrcd_baca_tidy,
          aes(x = year, y = paleoData_values, colour = dataSetName))+
  geom_line()+
  # Restrict y axis for BaCa from -0.025 to 0.1
```
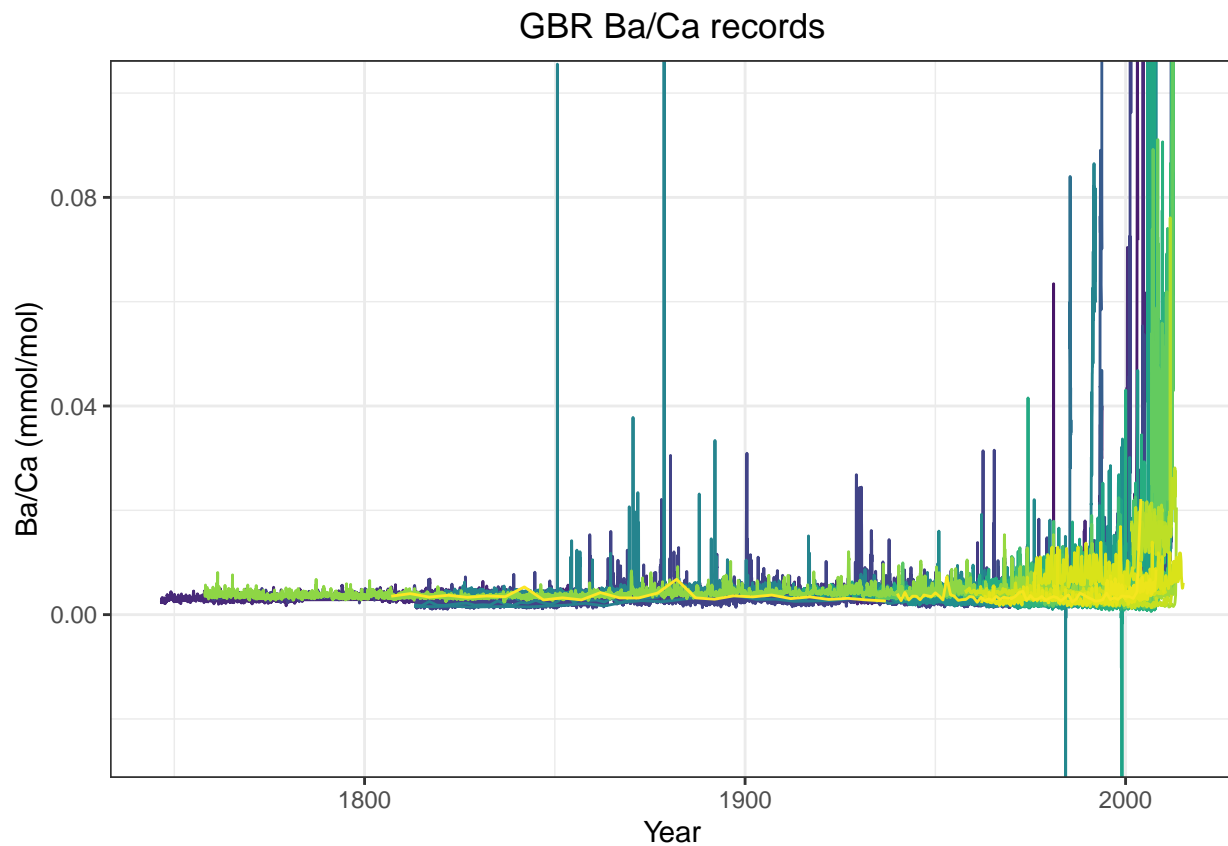
```
coord_cartesian(ylim=c(-0.025, 0.1), xlim = c())+
# Set colour theme used for records
scale_colour_viridis_d()+
# Set plot, y axis and x axis titles
ggtitle("GBR Ba/Ca records")+
ylab("Ba/Ca (mmol/mol)")+
xlab("Year")+
theme_bw()+
# Suppress legend due to number of records and centre align title
theme(legend.position="none", plot.title = element_text(hjust = 0.5))
```

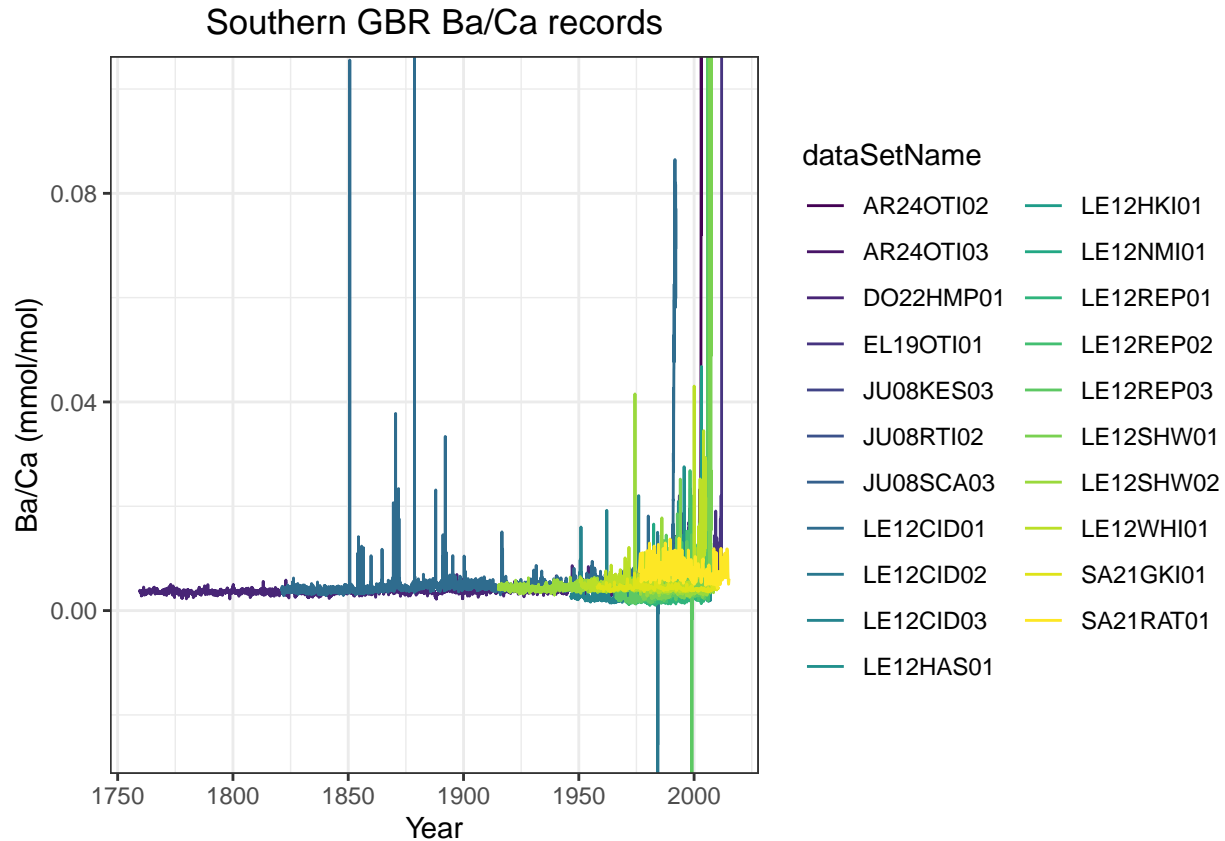## GBR Ba/Ca records


```
# Plot Ba/Ca records for only the southern GBR
ggplot(gbrcd_baca_tidy %>%
  # Filter four 'southern GBR' latitudes
      filter(geo_latitude < -20 ),
    aes(x = year, y = paleoData_values, colour = dataSetName))+
  geom_line()+
  # Restrict y axis for BaCa from -0.025 to 0.1
  coord_cartesian(ylim=c(-0.025, 0.1))+
  # Set colour theme used for records
  scale_colour_viridis_d()+
  # Set plot, y axis and x axis titles
  ggtitle("Southern GBR Ba/Ca records")+
  ylab("Ba/Ca (mmol/mol)")+
  xlab("Year")+
```

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```
theme_bw()+
# Centre align title
theme(plot.title = element_text(hjust = 0.5))
```

Southern GBR Ba/Ca records


```
# Plot only southern GBR and records latitudes south of -22.5
ggplot(gbrcd_baca_tidy %>%
  # Filter for select southern GBR latitudes
         filter(geo_latitude < -22.5),
       aes(x = year, y = paleoData_values))+
  # Plot all BaCa records as the same colour
  geom_line(colour = "#CD661D")+
  # Restrict y axis for BaCa from 0 to 0.025 and x axis ages to after 1950
  coord_cartesian(ylim=c(0, 0.025), xlim=c(1950, 2020))+
  # Set plot, y axis and x axis titles
  ggtitle("Select Southern GBR Ba/Ca records time series stack")+
  ylab("Ba/Ca (mmol/mol)")+
  xlab("Year")+
  # Create record time series stack by ID
  facet_grid("dataSetName")+
  theme_bw()+
  # Centre align title  & set horizontal direction for facet label
  theme(plot.title = element_text(hjust = 0.5), strip.text.y = element_text(angle = 0))
```

Select Southern GBR Ba/Ca records time series stack