

# ***bilbao***

a scientific colour-map - [www.fabiocrameri.ch/bilbao](http://www.fabiocrameri.ch/bilbao)

[Crameri \(2018\)](#)

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## **Characteristics**

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- Perceptually uniform ✓
- Perceptually ordered ✓
- Colour-vision-deficiency (CVD) friendly ✓
- Readable as black and white print ✓
- Sequential
- White completion; no black

## **Authors & Contributors**

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- **Krister Stræte Karlsen** - *User instruction for use with python* - [contact](#)
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- **Emilia** - *Plotly versions* - [contact](#)
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- **Wolfgang Schwanghart** - *Built-in version for 'TopoToolbox'* - [contact](#)
- **Chad Greene** - *MatLab file exchange version* - [contact](#)

## **Acknowledgement**

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Please acknowledge the free use of the colour map.

e.g., "The perceptually uniform colour-map ***bilbao*** is used in this study to prevent visual distortion of the data (Crameri 2018a,b)."

Crameri, F. (2018a), *Scientific colour-maps*. Zenodo. <http://doi.org/10.5281/zenodo.1243862>

Crameri, F. (2018b), *Geodynamic diagnostics, scientific visualisation and StagLab 3.0*, *Geosci. Model Dev.*, 11, 2541-2562, doi:10.5194/gmd-11-2541-2018

## Instructions

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### Using the .mat Format (MatLab)

Load the colour map into MatLab, either by adding the .mat file to the MatLab search path and using the command:

```
load('bilbao.mat');
```

or by specifying the full file path to the .mat file:

```
load('~/.work/Colormaps/bilbao.mat');
```

Then use it, for example, with:

```
figure(1)
colormap(bilbao)
colorbar
```

### Using the file-exchange app (MatLab)

A convenient MatLab package provided by Chad Greene containing the full scientific colour-map suite is available on [MatLab file exchange](#).

### Using the .cpt Format (GMT)

The file bilbao.cpt can be resampled for a given z-value range with the Generic Mapping Tools (GMT; <http://gmt.soest.hawaii.edu/>) command "makecpt".

For example to resample for an array from -2000 to 2000 in 100 increments you could generate a new file with:

```
$makecpt -Cbilbao.cpt -T-2000/2000/100 > bilbao_resampled.cpt
```

### Using the .ct Format (VisIt)

The file bilbao.ct can be imported to VisIt by placing the .ct file in the .visit directory, which can be found on

macOS under e.g.,:

```
/Applications/VisIt.app/Contents/Resources/ ...  
... 2.12.3/darwin-x86_64/resources/colortables
```

The colour map should appear in the built-in list after VisIt has been restarted.

## Using the .mat Format (Mathematica)

```
ColorMapSuitePath = "/Path/To/ColourMapSuite/";  
  
ColorMapSuite[name_String] := ColorMapSuite[name, -1]  
ColorMapSuite[name_String, el_] := With[{  
  list =  
    Transpose@{Subdivide[0, 1, 255],  
      RGBColor @@@  
        First@Import[  
          ColorMapSuitePath <> "/" <> name <> "/" <> name <> ".mat"]}  
    },  
  Blend[list, {##}][[el]]] &  
]
```

The function call `ColorMapSuite["name", i = -1]` returns a lambda function whose *i*th argument is used to define color (see the Manual for `ColorFunction` for details). `"name"` should be replaced with the name (in quotes) of the color scheme, e.g. `"bilbao"`. Be sure to set the variable `ColorMapSuitePath` to the path where your ColorMapSuite is installed.

General rules are:

- 1D plots of 1D functions/data: no (default) argument *i* suffices
- 2D plots of 2D functions/data: no (default) argument *i* suffices
- 3D plots of 2D functions/data: use *i* = 3
- 3D plots of 3D functions/data: use *i* = 4 (results might be worse than default Mathematica color functions, possibly due to lack of surface normal mapping)

```
ContourPlot[Sin[x] Sin[y], {x, 0, 2 Pi},  
{y, 0, 2 Pi}, ColorFunction -> ColorMapSuite["bilbao"]]
```

## Using the .xml Format (QGIS)

Load the colour-map into QGIS in:

```
Settings > Style manager > Import/Export > Import symbol(s) > select the xxx_QGIS.  
xml file.
```

## Using the .txt Format (Python)

### Step 1: Load colour-map data

Load the colour-map data into Python using `numpy.loadtxt()` :

```
import numpy as np
cm_data = np.loadtxt("bilbao.txt")
```

### Step 2: Set up colour map

Use `matplotlib.colors.LinearSegmentedColormap()` to create a colour map that can be used with matplotlib.

```
from matplotlib.colors import LinearSegmentedColormap
bilbao_map = LinearSegmentedColormap.from_list('bilbao', cm_data)
```

### Complete example:

```
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.colors import LinearSegmentedColormap

cm_data = np.loadtxt("bilbao_RGB(0-1).txt")
bilbao_map = LinearSegmentedColormap.from_list('bilbao', cm_data)

x = np.linspace(0, 100, 100)[None, :]
plt.imshow(x, aspect='auto', cmap=bilbao_map)
plt.axis('off')
plt.show()
```

## Using the .py Format (plotly)

Plotly versions of the scientific colour-maps are provided by Emilia are available at <https://github.com/empet/scientific-colorscales>.

The plotly scientific colour-maps (see the file `scicolorscales.py`) were created by converting the provided .py file of each colour map.

Direct applications and some scientific tests are illustrated in this Jupyter Notebook:

<http://nbviewer.jupyter.org/github/empet/scientific-colorscales/blob/master/Tests-for-scientific-colorscales.ipynb>.

## Using the .xml format (d3)

An instruction to convert the .xml format to d3's internal representation is provided by Philippe Rivière at <https://beta.observablehq.com/@fil/colormaps>.

## Using the scico package (R)

`scico` (<https://travis-ci.org/thomasp85/scico>; pronounced as "psycho") is a small package developed by Thomas Lin Pedersen that provides access to the scientific colour-maps within R. It provides scales for `ggplot2` without requiring `ggplot2` to be installed.

`scico` can be installed from CRAN with `install.packages('scico')`. If you want the development version then install directly from GitHub:

```
# install.packages("devtools")
devtools::install_github("thomasp85/scico")
```

For further details and user instructions are included in a README file within `scico`.

## Software with built-in versions

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[StagLab](#)

[GMT](#)

[TopoToolbox](#)

[SubMachine](#)

## References

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Included colour-map diagnostics are based on:

- Kovesi (2015), *Good Colour Maps: How to Design Them*, CoRR, *abs/1509.03700*, <http://arxiv.org/abs/1509.03700> and related MatLab functions available at <https://www.peterkovesi.com/matlabfns/index.html#colour>.

For further details see:

- Cramer, F. (2018), *Geodynamic diagnostics, scientific visualisation and StagLab 3.0*, *Geosci. Model Dev. Discuss.*, [doi:10.5194/gmd-2017-328](https://doi.org/10.5194/gmd-2017-328)

## License

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