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# Tile Recipes

The Tile classes are in the **geoscript.layer** package.

## Tile

### Tile Properties

Get a Tile's Properties.

```
byte[] data = new File("src/main/resources/tile.png").bytes
Tile tile = new Tile(2,1,3,data)
println "Z = ${tile.z}"
println "X = ${tile.x}"
println "Y = ${tile.y}"
println "Tile = ${tile.toString()}"
println "# bytes = ${tile.data.length}"
println "Data as base64 encoded string = ${tile.base64String}"
```

```
Z = 2
X = 1
Y = 3
Tile = Tile(x:1, y:3, z:2)
# bytes = 11738
Data as base64 encoded string = iVBORw0KGgoAAAANSUhEUgAAAQAAAAEACAYAAABccqhmAAAtoU...
```

### ImageTile Properties

Some Tiles contain an Image. ImageTile's have an image property.

```
byte[] data = new File("src/main/resources/tile.png").bytes
ImageTile tile = new ImageTile(0,0,0,data)
BufferedImage image = tile.image
```

# Grid

A Grid describes a level in a Pyramid of Tiles.

### Grid Properties

```
Grid grid = new Grid(1, 2, 2, 78206.0, 78206.0)
println "Zoom Level: ${grid.z}"
println "Width / # Columns: ${grid.width}"
println "Height / # Rows: ${grid.height}"
println "Size / # Tiles: ${grid.size}"
println "X Resolution: ${grid.xResolution}"
println "Y Resolution: ${grid.yResolution}"
```

```
Zoom Level: 1
Width / # Columns: 2
Height / # Rows: 2
Size / # Tiles: 4
X Resolution: 78206.0
Y Resolution: 78206.0
```

# Pyramid

## Pyramid Properties

Get the Pyramid's Bounds.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()

Bounds bounds = pyramid.bounds
println bounds
```

```
(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
```

Get the Pyramid's projection.

```
Projection proj = pyramid.proj
println proj
```

```
EPSG:3857
```

Get the Pyramid's Origin.

```
Pyramid.Origin origin = pyramid.origin
println origin
```

```
BOTTOM_LEFT
```

Get the Pyramid's Tile Width and Height.

```
int tileWidth = pyramid.tileWidth
int tileHeight = pyramid.tileHeight
println "${tileWidth} x ${tileHeight}"
```

```
256 x 256
```

## Create Pyramids

Create a Global Mercator Pyramid.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
println "Projection: ${pyramid.proj}"
println "Origin: ${pyramid.origin}"
println "Bounds: ${pyramid.bounds}"
println "Max Zoom: ${pyramid.maxGrid.z}"
```

```
Projection: EPSG:3857
Origin: BOTTOM_LEFT
Bounds: (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
Max Zoom: 19
```

Create a Global Geodetic Pyramid.

```
Pyramid pyramid = Pyramid.createGlobalGeodeticPyramid()
println "Projection: ${pyramid.proj}"
println "Origin: ${pyramid.origin}"
println "Bounds: ${pyramid.bounds}"
println "Max Zoom: ${pyramid.maxGrid.z}"
```

```
Projection: EPSG:4326
Origin: BOTTOM_LEFT
Bounds: (-179.99,-89.99,179.99,89.99,EPSG:4326)
Max Zoom: 19
```

Create a Global Mercator Pyramid from a well known name.

Well known names include:

- GlobalMercator
- Mercator
- GlobalMercatorBottomLeft
- GlobalMercatorTopLeft
- GlobalGeodetic
- Geodetic

```
Pyramid pyramid = Pyramid.fromString("mercator")
println "Projection: ${pyramid.proj}"
println "Origin: ${pyramid.origin}"
println "Bounds: ${pyramid.bounds}"
println "Max Zoom: ${pyramid.maxGrid.z}"
```

```
Projection: EPSG:3857
Origin: BOTTOM_LEFT
Bounds: (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
Max Zoom: 19
```

## Get Bounds from a Pyramid

Get the Bounds for a Tile.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Tile tile = new Tile(2, 1, 1)
Bounds bounds = pyramid.bounds(tile)
println "The bounds of ${tile} is ${bounds}"
```

```
The bounds of Tile(x:1, y:1, z:2) is (-1.0018197573940655E7,-
1.0018735602568535E7,0.0,-3.725290298461914E-9,EPSG:3857)
```

Get the Bounds for an area around a Point at a zoom level.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Point point = Projection.transform(new Point(22.1539306640625, 37.67077737288316),
"EPSG:4326", "EPSG:3857")
int zoomLevel = 8
int width = 400
int height = 400
Bounds bounds = pyramid.bounds(point, zoomLevel, width, height)
println "The bounds around ${point} is ${bounds}"
```

```
The bounds around POINT (2466164.280592927 4533021.525424092) is
(2343967.405592927,4410824.650424092,2588361.155592927,4655218.400424092,EPSG:3857)
```

## Get a Grid from a Pyramid

Get a the min Grid.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Grid grid = pyramid.minGrid
println "Zoom Level: ${grid.z}"
println "Width / # Columns: ${grid.width}"
println "Height / # Rows: ${grid.height}"
println "Size / # Tiles: ${grid.size}"
println "X Resolution: ${grid.xResolution}"
println "Y Resolution: ${grid.yResolution}"
```

```
Zoom Level: 0
Width / # Columns: 1
Height / # Rows: 1
Size / # Tiles: 1
X Resolution: 156412.0
Y Resolution: 156412.0
```

Get a the max Grid.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Grid grid = pyramid.maxGrid
println "Zoom Level: ${grid.z}"
println "Width / # Columns: ${grid.width}"
println "Height / # Rows: ${grid.height}"
println "Size / # Tiles: ${grid.size}"
println "X Resolution: ${grid.xResolution}"
println "Y Resolution: ${grid.yResolution}"
```

```
Zoom Level: 19
Width / # Columns: 524288
Height / # Rows: 524288
Size / # Tiles: 274877906944
X Resolution: 0.29833221435546875
Y Resolution: 0.29833221435546875
```

Get a Grid from a Pyramid by Zoom Level.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Grid grid = pyramid.grid(1)
println "Zoom Level: ${grid.z}"
println "Width / # Columns: ${grid.width}"
println "Height / # Rows: ${grid.height}"
println "Size / # Tiles: ${grid.size}"
println "X Resolution: ${grid.xResolution}"
println "Y Resolution: ${grid.yResolution}"
```

```
Zoom Level: 1
Width / # Columns: 2
Height / # Rows: 2
Size / # Tiles: 4
X Resolution: 78206.0
Y Resolution: 78206.0
```

Get a Grid from a Pyramid by a Bounds and Resolution.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Bounds bounds = new Bounds(-123.09, 46.66, -121.13, 47.48, "EPSG:4326").reproject
("EPSG:3857")
Grid grid = pyramid.grid(bounds, bounds.width / 400.0, bounds.height / 200.0)
println "Zoom Level: ${grid.z}"
println "Width / # Columns: ${grid.width}"
println "Height / # Rows: ${grid.height}"
println "Size / # Tiles: ${grid.size}"
println "X Resolution: ${grid.xResolution}"
println "Y Resolution: ${grid.yResolution}"
```

```
Zoom Level: 8
Width / # Columns: 256
Height / # Rows: 256
Size / # Tiles: 65536
X Resolution: 610.984375
Y Resolution: 610.984375
```

Get a Grid from a Pyramid by a Bounds and Size.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Bounds bounds = new Bounds(-123.09, 46.66, -121.13, 47.48, "EPSG:4326").reproject
("EPSG:3857")
Grid grid = pyramid.grid(bounds, 400, 200)
println "Zoom Level: ${grid.z}"
println "Width / # Columns: ${grid.width}"
println "Height / # Rows: ${grid.height}"
println "Size / # Tiles: ${grid.size}"
println "X Resolution: ${grid.xResolution}"
println "Y Resolution: ${grid.yResolution}"
```

```
Zoom Level: 8
Width / # Columns: 256
Height / # Rows: 256
Size / # Tiles: 65536
X Resolution: 610.984375
Y Resolution: 610.984375
```

### Get Tile Coordinates

Get the tile coordinates from a Pyramid by Bounds and zoom level

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Bounds bounds = new Bounds(-124.73142200000001, 24.955967, -66.969849, 49.371735,
"EPSG:4326").reproject("EPSG:3857")
long zoomLevel = 4
Map<String, Integer> coords = pyramid.getTileCoordinates(bounds, zoomLevel)
println "Min X = ${coords.minX}"
println "Min Y = ${coords.minY}"
println "Max X = ${coords.maxX}"
println "Max Y = ${coords.maxY}"
```

```
Min X = 2
Min Y = 9
Max X = 5
Max Y = 10
```

Get the tile coordinates from a Pyramid by Bounds and Grid

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
Bounds bounds = new Bounds(20.798492,36.402494,22.765045,37.223768, "EPSG:4326"
).reproject("EPSG:3857")
Grid grid = pyramid.grid(10)
Map<String, Integer> coords = pyramid.getTileCoordinates(bounds, grid)
println "Min X = ${coords.minX}"
println "Min Y = ${coords.minY}"
println "Max X = ${coords.maxX}"
println "Max Y = ${coords.maxY}"
```

```
Min X = 571
Min Y = 623
Max X = 576
Max Y = 626
```

## Reading and Writing Pyramids

The Pyramid IO classes are in the **geoscript.layer.io** package.

### Finding Pyramid Writer and Readers

*List all Pyramid Writers*

```
List<PyramidWriter> writers = PyramidWriters.list()
writers.each { PyramidWriter writer ->
    println writer.class.simpleName
}
```

```
CsvPyramidWriter
GdalTmsPyramidWriter
JsonPyramidWriter
XmlPyramidWriter
```

*Find a Pyramid Writer*

```
Pyramid pyramid = Pyramid.createGlobalGeodeticPyramid(maxZoom: 2)
PyramidWriter writer = PyramidWriters.find("csv")
String pyramidStr = writer.write(pyramid)
println pyramidStr
```

```
EPSG:4326
-179.99,-89.99,179.99,89.99,EPSG:4326
BOTTOM_LEFT
256,256
0,2,1,0.703125,0.703125
1,4,2,0.3515625,0.3515625
2,8,4,0.17578125,0.17578125
```

*List all Pyramid Readers*

```
List<PyramidReader> readers = PyramidReaders.list()
readers.each { PyramidReader reader ->
    println reader.class.simpleName
}
```

```
CsvPyramidReader
GdalTmsPyramidReader
JsonPyramidReader
XmlPyramidReader
```

*Find a Pyramid Reader*

```
        PyramidReader reader = PyramidReaders.find("csv")
        Pyramid pyramid = reader.read("""EPSG:3857
-2.0036395147881314E7,
-2.0037471205137067E7,2.0036395147881314E7,2.0037471205137067E7,EPSG:3857
BOTTOM_LEFT
256,256
0,1,1,156412.0,156412.0
1,2,2,78206.0,78206.0
2,4,4,39103.0,39103.0
3,8,8,19551.5,19551.5
4,16,16,9775.75,9775.75
""")
        println pyramid
```

```
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.0036395147881314E7,-
2.0037471205137067E7,2.0036395147881314E7,2.0037471205137067E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

### JSON

Get a JSON String from a Pyramid.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid(maxZoom: 4)
String json = pyramid.json
println json
```

```
{
    "proj": "EPSG:3857",
    "bounds": {
        "minX": -2.003639514788131E7,
        "minY": -2.0037471205137067E7,
        "maxX": 2.003639514788131E7,
        "maxY": 2.0037471205137067E7
    },
    "origin": "BOTTOM_LEFT",
    "tileSize": {
        "width": 256,
        "height": 256
    },
    "grids": [
        {
            "z": 0,
            "width": 1,
            "height": 1,
            "xres": 156412.0,
```

```
            "yres": 156412.0
        },
        {
            "z": 1,
            "width": 2,
            "height": 2,
            "xres": 78206.0,
            "yres": 78206.0
        },
        {
            "z": 2,
            "width": 4,
            "height": 4,
            "xres": 39103.0,
            "yres": 39103.0
        },
        {
            "z": 3,
            "width": 8,
            "height": 8,
            "xres": 19551.5,
            "yres": 19551.5
        },
        {
            "z": 4,
            "width": 16,
            "height": 16,
            "xres": 9775.75,
            "yres": 9775.75
        }
    ]
}
```

**XML**

Get a XML String from a Pyramid.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid(maxZoom: 4)
String xml = pyramid.xml
println xml
```

```
<pyramid>
  <proj>EPSG:3857</proj>
  <bounds>
    <minX>-2.003639514788131E7</minX>
    <minY>-2.0037471205137067E7</minY>
    <maxX>2.003639514788131E7</maxX>
    <maxY>2.003747120513706E7</maxY>
  </bounds>
```

```
  <origin>BOTTOM_LEFT</origin>
  <tileSize>
    <width>256</width>
    <height>256</height>
  </tileSize>
  <grids>
    <grid>
      <z>0</z>
      <width>1</width>
      <height>1</height>
      <xres>156412.0</xres>
      <yres>156412.0</yres>
    </grid>
    <grid>
      <z>1</z>
      <width>2</width>
      <height>2</height>
      <xres>78206.0</xres>
      <yres>78206.0</yres>
    </grid>
    <grid>
      <z>2</z>
      <width>4</width>
      <height>4</height>
      <xres>39103.0</xres>
      <yres>39103.0</yres>
    </grid>
    <grid>
      <z>3</z>
      <width>8</width>
      <height>8</height>
      <xres>19551.5</xres>
      <yres>19551.5</yres>
    </grid>
    <grid>
      <z>4</z>
      <width>16</width>
      <height>16</height>
      <xres>9775.75</xres>
      <yres>9775.75</yres>
    </grid>
  </grids>
</pyramid>
```

**CSV**

Get a CSV String from a Pyramid.

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid(maxZoom: 4)
String csv = pyramid.csv
println csv
```

```
EPSG:3857
-2.003639514788131E7,
-2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857
BOTTOM_LEFT
256,256
0,1,1,156412.0,156412.0
1,2,2,78206.0,78206.0
2,4,4,39103.0,39103.0
3,8,8,19551.5,19551.5
4,16,16,9775.75,9775.75
```

#### GDAL XML

Write a Pyramid to a GDAL XML File

```
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid(maxZoom: 4)
GdalTmsPyramidWriter writer = new GdalTmsPyramidWriter()
String xml = writer.write(pyramid, serverUrl: 'https://myserver.com/${z}/${x}/${y}',
imageFormat: 'png')
println xml
```

```
<GDAL_WMS>
  <Service name='TMS'>
    <ServerURL>https://myserver.com/${z}/${x}/${y}</ServerURL>
    <SRS>EPSG:3857</SRS>
    <ImageFormat>png</ImageFormat>
  </Service>
  <DataWindow>
    <UpperLeftX>-2.003639514788131E7</UpperLeftX>
    <UpperLeftY>2.003747120513706E7</UpperLeftY>
    <LowerRightX>2.003639514788131E7</LowerRightX>
    <LowerRightY>-2.0037471205137067E7</LowerRightY>
    <TileLevel>4</TileLevel>
    <TileCountX>1</TileCountX>
    <TileCountY>1</TileCountY>
    <YOrigin>bottom</YOrigin>
  </DataWindow>
  <Projection>EPSG:3857</Projection>
  <BlockSizeX>256</BlockSizeX>
  <BlockSizeY>256</BlockSizeY>
  <BandsCount>3</BandsCount>
</GDAL_WMS>
```

Read a Pyramid from a GDAL XML File

```
        String xml = '''<GDAL_WMS>
  <Service name='TMS'>
    <ServerURL>https://myserver.com/${z}/${x}/${y}</ServerURL>
    <SRS>EPSG:3857</SRS>
    <ImageFormat>png</ImageFormat>
  </Service>
  <DataWindow>
    <UpperLeftX>-2.0036395147881314E7</UpperLeftX>
    <UpperLeftY>2.003747120513706E7</UpperLeftY>
    <LowerRightX>2.0036395147881314E7</LowerRightX>
    <LowerRightY>-2.0037471205137067E7</LowerRightY>
    <TileLevel>4</TileLevel>
    <TileCountX>1</TileCountX>
    <TileCountY>1</TileCountY>
    <YOrigin>bottom</YOrigin>
  </DataWindow>
  <Projection>EPSG:3857</Projection>
  <BlockSizeX>256</BlockSizeX>
  <BlockSizeY>256</BlockSizeY>
  <BandsCount>3</BandsCount>
</GDAL_WMS>'''
        GdalTmsPyramidReader reader = new GdalTmsPyramidReader()
        Pyramid pyramid = reader.read(xml)
```

```
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.0036395147881314E7,-
2.0037471205137067E7,2.0036395147881314E7,2.003747120513706E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

# Generating Tiles

## Generating Image Tiles

### MBTiles

Generate Image Tiles to a MBTiles file

```
File file = new File("target/world.mbtiles")
MBTiles mbtiles = new MBTiles(file, "World", "World Tiles")

Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")
countries.style = new Fill("#ffffff") + new Stroke("#b2b2b2", 0.5)
Layer ocean = workspace.get("ocean")
ocean.style = new Fill("#a5bfdd")

ImageTileRenderer renderer = new ImageTileRenderer(mbtiles, [ocean, countries])
TileGenerator generator = new TileGenerator()
generator.generate(mbtiles, renderer, 0, 2)
```

Generate Image Tiles to a MBTiles file with metatiles

```
File file = new File("target/world_meta.mbtiles")
MBTiles mbtiles = new MBTiles(file, "World", "World Tiles")

Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")
countries.style = new Fill("#ffffff") + new Stroke("#b2b2b2", 0.5)
Layer ocean = workspace.get("ocean")
ocean.style = new Fill("#a5bfdd")

ImageTileRenderer renderer = new ImageTileRenderer(mbtiles, [ocean, countries])
TileGenerator generator = new TileGenerator()
generator.generate(mbtiles, renderer,0, 2, metatile: [width:4, height: 4])
```

[tile generate mbtiles metatile] | *tile_generate_mbtiles_metatile.png*

#### DBTiles

Generate Image Tiles to a MBTiles like JDBC Database.

```
File file = new File("target/world_tiles.db")
DBTiles dbtiles = new DBTiles("jdbc:h2:${file}","org.h2.Driver", "World", "World wide
tiles")

Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")
countries.style = new Fill("#ffffff") + new Stroke("#b2b2b2", 0.5)
Layer ocean = workspace.get("ocean")
ocean.style = new Fill("#a5bfdd")

ImageTileRenderer renderer = new ImageTileRenderer(dbtiles, [ocean, countries])
TileGenerator generator = new TileGenerator()
generator.generate(dbtiles, renderer, 0, 2)
```

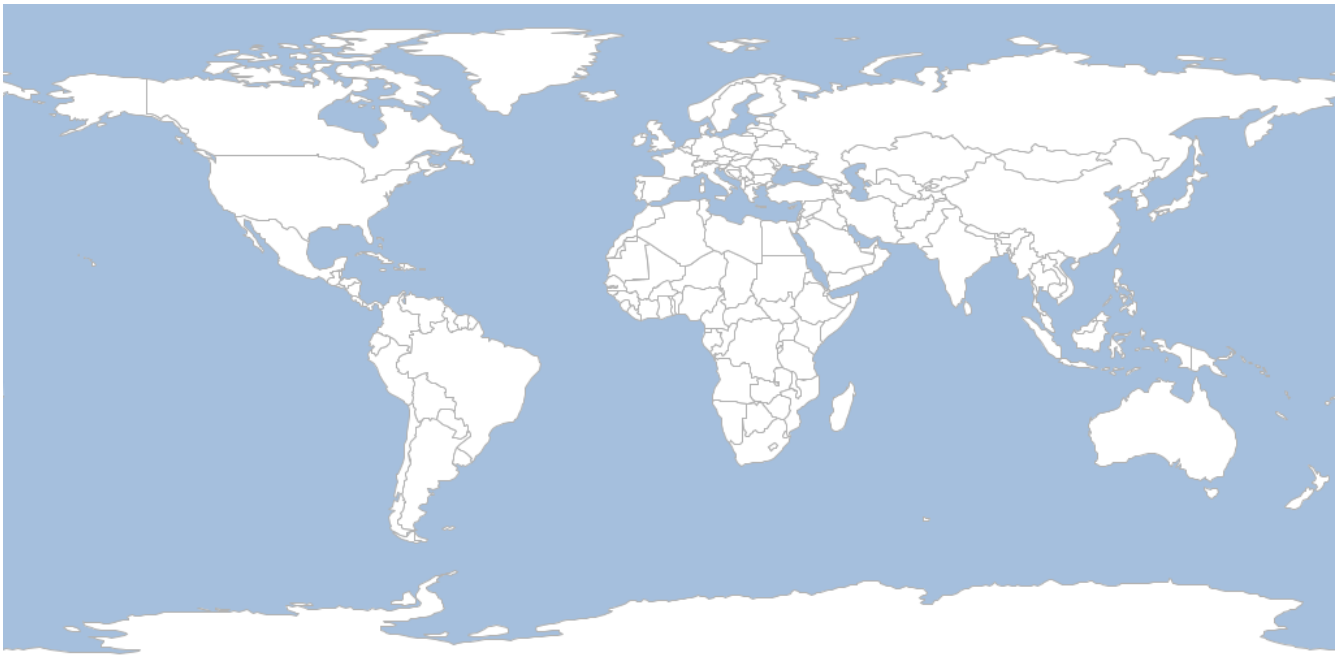
**GeoPackage**

Generate Image Tiles to a GeoPackage file

```
File file = new File("target/world.gpkg")
geoscript.layer.GeoPackage geopackage = new geoscript.layer.GeoPackage(file, "World",
Pyramid.createGlobalGeodeticPyramid())

Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")
countries.style = new Fill("#ffffff") + new Stroke("#b2b2b2", 0.5)
Layer ocean = workspace.get("ocean")
ocean.style = new Fill("#a5bfdd")

ImageTileRenderer renderer = new ImageTileRenderer(geopackage, [ocean, countries])
TileGenerator generator = new TileGenerator()
generator.generate(geopackage, renderer, 0, 2)
```



**TMS**

Generate Image Tiles to a TMS directory

```
File directory = new File("target/tiles")
directory.mkdir()
TMS tms = new TMS("world", "png", directory, Pyramid.createGlobalMercatorPyramid())

Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")
countries.style = new Fill("#ffffff") + new Stroke("#b2b2b2", 0.5)
Layer ocean = workspace.get("ocean")
ocean.style = new Fill("#a5bfdd")

ImageTileRenderer renderer = new ImageTileRenderer(tms, [ocean, countries])
TileGenerator generator = new TileGenerator()
generator.generate(tms, renderer, 0, 2)
```

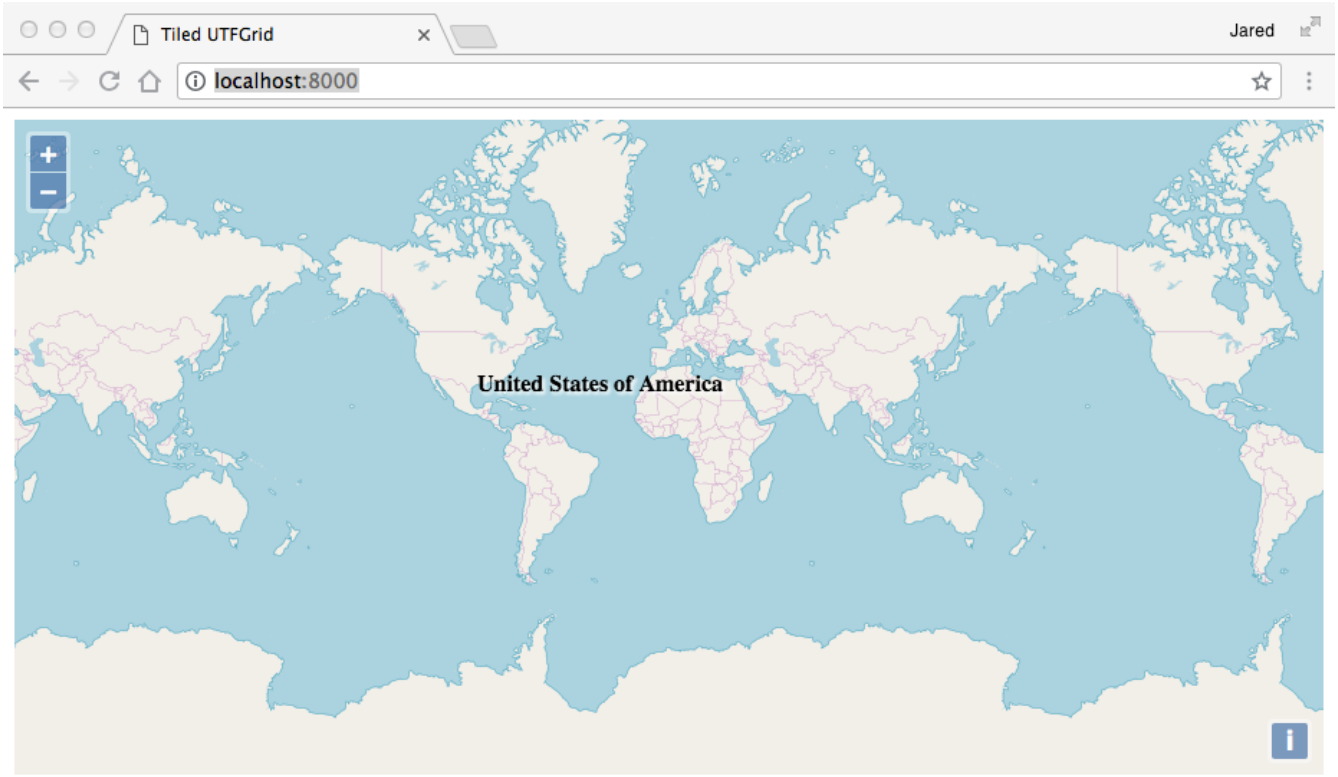
**UTFGrid**

Generate UTFGrid tiles to a directory

```
File directory = new File("target/utfgrid")
directory.mkdir()
UTFGrid utf = new UTFGrid(directory)

Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")

UTFGridTileRenderer renderer = new UTFGridTileRenderer(utf, countries, [countries
.schema.get("NAME")])
TileGenerator generator = new TileGenerator()
generator.generate(utf, renderer, 0, 2)
```




### Vector Tiles

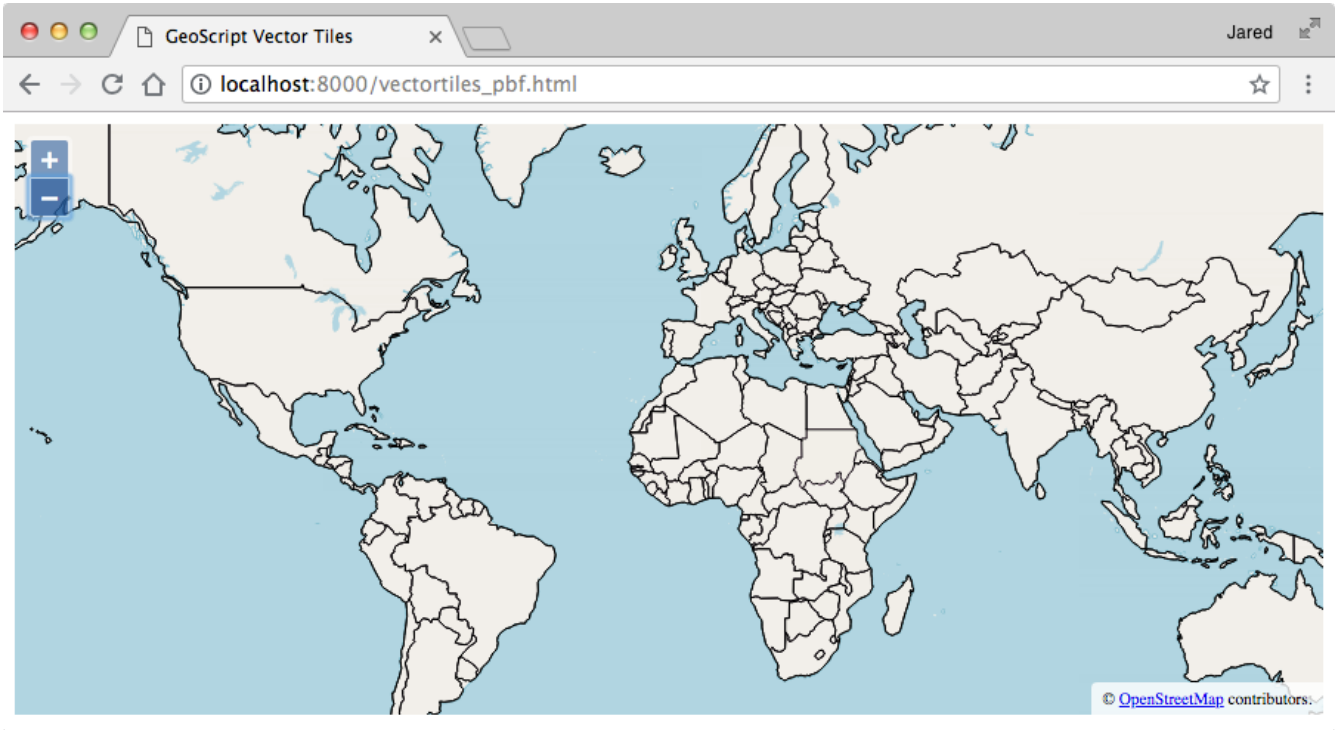
Generate vector tiles to a directory

```
File directory = new File("target/pbf")
directory.mkdir()

Workspace workspace = new Directory("src/main/resources/shapefiles")
Layer countries = workspace.get("countries")
Layer ocean = workspace.get("ocean")

Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
pyramid.origin = Pyramid.Origin.TOP_LEFT
VectorTiles vectorTiles = new VectorTiles(
    "world",
    directory,
    pyramid,
    "pbf",
    style: [
        "countries": new Fill("white") + new Stroke("black", 1),
        "ocean": new Fill("blue")
    ]
)

PbfVectorTileRenderer renderer = new PbfVectorTileRenderer([countries, ocean], [
    "countries": ["NAME"],
    "ocean": ["FeatureCla"]
])
TileGenerator generator = new TileGenerator()
generator.generate(vectorTiles, renderer, 0, 2)
```



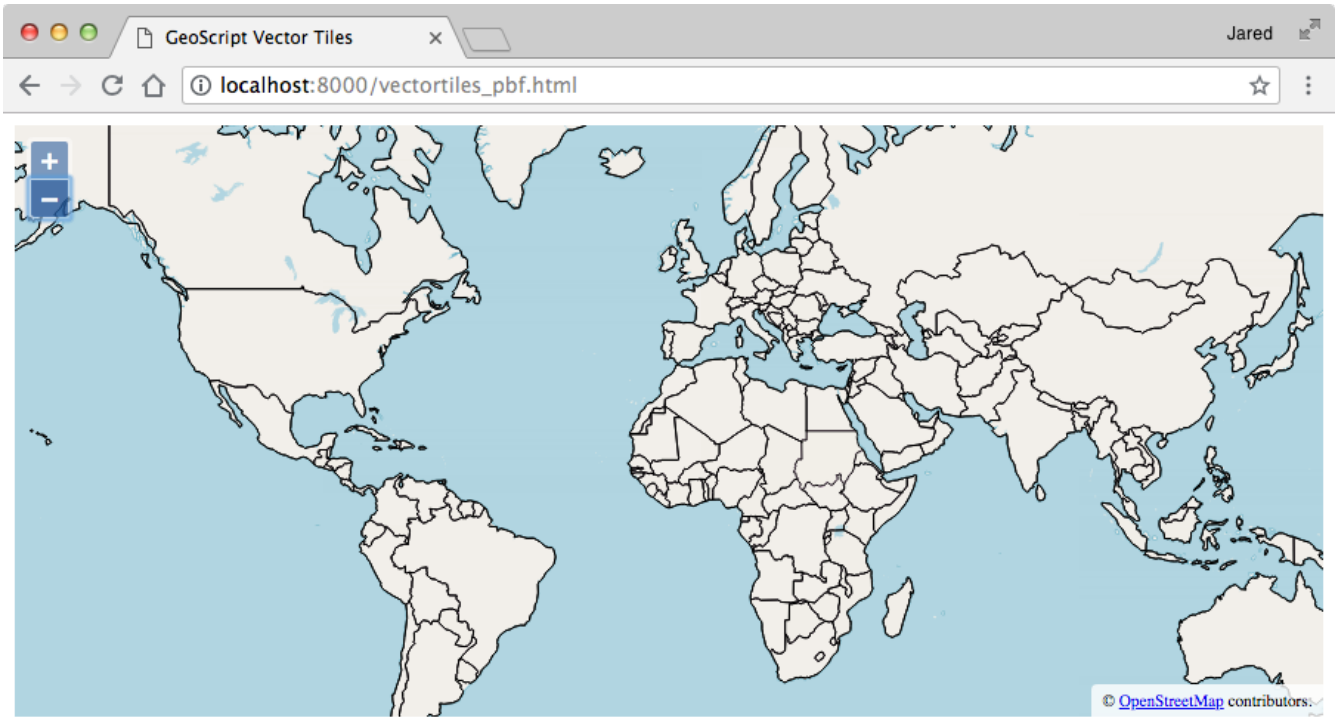

Generate vector tiles to a MBTiles file

```
File file = new File("target/vectortiles.mbtiles")

Workspace workspace = new Directory("src/main/resources/shapefiles")
Layer countries = workspace.get("countries")
Layer ocean = workspace.get("ocean")

Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
pyramid.origin = Pyramid.Origin.TOP_LEFT
VectorTiles vectorTiles = new VectorTiles(
    "world",
    file,
    pyramid,
    "pbf",
    style: [
            "countries": new Fill("white") + new Stroke("black", 1),
            "ocean": new Fill("blue")
    ]
)

PbfVectorTileRenderer renderer = new PbfVectorTileRenderer([countries, ocean], [
        "countries": ["NAME"],
        "ocean": ["FeatureCla"]
])
TileGenerator generator = new TileGenerator()
generator.generate(vectorTiles, renderer, 0, 2)
```




# Tile Layer

### Tile Layer Properties

Create a TileLayer from an MBTiles File.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)
```

Get the TileLayer's name.

```
String name = mbtiles.name
println name
```

```
countries
```

Get the TileLayer's Bounds.

```
Bounds bounds = mbtiles.bounds
println bounds
```

```
(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
```

Get the TileLayer's Projection.

```
Projection proj = mbtiles.proj
println proj
```

```
EPSG:3857
```

Get the TileLayer's Pyramid.

```
Pyramid pyramid = mbtiles.pyramid
println pyramid
```

```
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

Get a Tile from a TileLayer.

```
Tile tile = mbtiles.get(0, 0, 0)
println tile
```

```
Tile(x:0, y:0, z:0)
```

### Get, put, and delete a Tile from a TileLayer

Get a Tile from a TileLayer.

```
MBTiles layer = new MBTiles(file)
ImageTile tile = layer.get(0,0,0)
```

Add a Tile to a TileLayer.

```
File newTileFile = new File("src/main/resources/yellowtile.png")
ImageTile newTile = new ImageTile(0,0,0, newTileFile.bytes)
layer.put(newTile)
newTile = layer.get(0,0,0)
```

Remove a Tile from a TileLayer.

```
layer.delete(newTile)
newTile = layer.get(0,0,0)
println "Image = ${newTile.image}"
```

```
Image = null
```

Close a TileLayer

```
layer.close()
```

## Delete Tiles from a TileLayer

```
MBTiles layer = new MBTiles(file)
layer.tiles(1).each { Tile tile ->
    println "${tile} = ${tile.image == null}"
}
```

```
Tile(x:0, y:0, z:1) = false
Tile(x:1, y:0, z:1) = false
Tile(x:0, y:1, z:1) = false
Tile(x:1, y:1, z:1) = false
```

```
layer.delete(layer.tiles(1))
layer.tiles(1).each { Tile tile ->
    println "${tile} = ${tile.image == null}"
}
```

```
Tile(x:0, y:0, z:1) = true
Tile(x:1, y:0, z:1) = true
Tile(x:0, y:1, z:1) = true
Tile(x:1, y:1, z:1) = true
```

### Tiles

Get a TileCursor from a TileLayer with all of the Tiles in a zoom level.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

long zoomLevel = 1
TileCursor tileCursor = mbtiles.tiles(zoomLevel)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 1
# of tiles: 4
Bounds: (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
Width / # Columns: 2
Height / # Rows: 2
MinX: 0, MinY: 0, MaxX: 1, MaxY: 1

Tiles:
Tile(x:0, y:0, z:1)
Tile(x:1, y:0, z:1)
Tile(x:0, y:1, z:1)
Tile(x:1, y:1, z:1)
```

Get a TileCursor from a TileLayer with Tiles from a zoom level between min and max x and y coordinates.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

long zoomLevel = 4
long minX = 2
long minY = 4
long maxX = 5
long maxY = 8
TileCursor tileCursor = mbtiles.tiles(zoomLevel, minX, minY, maxX, maxY)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 4
# of tiles: 20
Bounds: (-1.5027296360910982E7,-1.0018735602568535E7,-
5009098.786970327,2504683.900642129,EPSG:3857)
Width / # Columns: 4
Height / # Rows: 5
MinX: 2, MinY: 4, MaxX: 5, MaxY: 8

Tiles:
Tile(x:2, y:4, z:4)
Tile(x:3, y:4, z:4)
Tile(x:4, y:4, z:4)
Tile(x:5, y:4, z:4)
Tile(x:2, y:5, z:4)
Tile(x:3, y:5, z:4)
Tile(x:4, y:5, z:4)
Tile(x:5, y:5, z:4)
Tile(x:2, y:6, z:4)
Tile(x:3, y:6, z:4)
Tile(x:4, y:6, z:4)
Tile(x:5, y:6, z:4)
Tile(x:2, y:7, z:4)
Tile(x:3, y:7, z:4)
Tile(x:4, y:7, z:4)
Tile(x:5, y:7, z:4)
Tile(x:2, y:8, z:4)
Tile(x:3, y:8, z:4)
Tile(x:4, y:8, z:4)
Tile(x:5, y:8, z:4)
```

Get a TileCursor from a TileLayer for a zoom level and a given Bounds.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

Bounds bounds = new Bounds(-102.875977, 45.433154, -96.481934, 48.118434,
"EPSG:4326").reproject("EPSG:3857")
int zoomLevel = 8
TileCursor tileCursor = mbtiles.tiles(bounds, zoomLevel)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 8
# of tiles: 24
Bounds: (-1.1583540944868883E7,5635538.7764447965,-
1.0644334922311947E7,6261709.751605326,EPSG:3857)
Width / # Columns: 6
Height / # Rows: 4
MinX: 54, MinY: 164, MaxX: 59, MaxY: 167

Tiles:
Tile(x:54, y:164, z:8)
Tile(x:55, y:164, z:8)
Tile(x:56, y:164, z:8)
Tile(x:57, y:164, z:8)
Tile(x:58, y:164, z:8)
Tile(x:59, y:164, z:8)
Tile(x:54, y:165, z:8)
Tile(x:55, y:165, z:8)
Tile(x:56, y:165, z:8)
Tile(x:57, y:165, z:8)
Tile(x:58, y:165, z:8)
Tile(x:59, y:165, z:8)
Tile(x:54, y:166, z:8)
Tile(x:55, y:166, z:8)
Tile(x:56, y:166, z:8)
Tile(x:57, y:166, z:8)
Tile(x:58, y:166, z:8)
Tile(x:59, y:166, z:8)
Tile(x:54, y:167, z:8)
Tile(x:55, y:167, z:8)
Tile(x:56, y:167, z:8)
Tile(x:57, y:167, z:8)
Tile(x:58, y:167, z:8)
Tile(x:59, y:167, z:8)
```

Get a TileCursor from a TileLayer for a zoom level and given x and y resolutions.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

Bounds bounds = new Bounds(-124.73142200000001, 24.955967, -66.969849, 49.371735,
"EPSG:4326").reproject("EPSG:3857")
double resolutionX = bounds.width / 400
double resolutionY = bounds.height / 300
TileCursor tileCursor = mbtiles.tiles(bounds, resolutionX, resolutionY)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 4
# of tiles: 8
Bounds: (-1.5027296360910982E7,2504683.9006421305,-
5009098.786970327,7514051.701926393,EPSG:3857)
Width / # Columns: 4
Height / # Rows: 2
MinX: 2, MinY: 9, MaxX: 5, MaxY: 10

Tiles:
Tile(x:2, y:9, z:4)
Tile(x:3, y:9, z:4)
Tile(x:4, y:9, z:4)
Tile(x:5, y:9, z:4)
Tile(x:2, y:10, z:4)
Tile(x:3, y:10, z:4)
Tile(x:4, y:10, z:4)
Tile(x:5, y:10, z:4)
```

Get a TileCursor from a TileLayer for a Bounds and a given canvas width and height.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

Bounds bounds = new Bounds(-102.875977, 45.433154, -96.481934, 48.118434,
"EPSG:4326").reproject("EPSG:3857")
int width = 400
int height = 400
TileCursor tileCursor = mbtiles.tiles(bounds, width, height)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 7
# of tiles: 6
Bounds: (-1.1583540944868883E7,5635538.7764447965,-
1.0644334922311947E7,6261709.751605329,EPSG:3857)
Width / # Columns: 3
Height / # Rows: 2
MinX: 27, MinY: 82, MaxX: 29, MaxY: 83

Tiles:
Tile(x:27, y:82, z:7)
Tile(x:28, y:82, z:7)
Tile(x:29, y:82, z:7)
Tile(x:27, y:83, z:7)
Tile(x:28, y:83, z:7)
Tile(x:29, y:83, z:7)
```

Get a TileCursor from a TileLayer around a Point at a given zoom level for a given canvas width and height.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

Point point = Projection.transform(new Point(-102.875977, 45.433154), "EPSG:4326",
"EPSG:3857")
int zoomLevel = 12
int width = 400
int height = 400
TileCursor tileCursor = mbtiles.tiles(point, zoomLevel, width, height)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 12
# of tiles: 9
Bounds: (-1.1466140192049265E7,5674674.46239233,-
1.1436790003844362E7,5704026.226852979,EPSG:3857)
Width / # Columns: 3
Height / # Rows: 3
MinX: 876, MinY: 2628, MaxX: 878, MaxY: 2630

Tiles:
Tile(x:876, y:2628, z:12)
Tile(x:877, y:2628, z:12)
Tile(x:878, y:2628, z:12)
Tile(x:876, y:2629, z:12)
Tile(x:877, y:2629, z:12)
Tile(x:878, y:2629, z:12)
Tile(x:876, y:2630, z:12)
Tile(x:877, y:2630, z:12)
Tile(x:878, y:2630, z:12)
```

Get the tile coordinates from a TileLayer by Bounds and Grid

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)
Bounds bounds = new Bounds(20.798492,36.402494,22.765045,37.223768, "EPSG:4326"
).reproject("EPSG:3857")
Grid grid = mbtiles.pyramid.grid(10)
Map<String, Integer> coords = mbtiles.getTileCoordinates(bounds, grid)
println "Min X = ${coords.minX}"
println "Min Y = ${coords.minY}"
println "Max X = ${coords.maxX}"
println "Max Y = ${coords.maxY}"
```

```
Min X = 571
Min Y = 623
Max X = 576
Max Y = 626
```

Get a Layer from a TileLayer representing the outline of the Tiles in the TileCursor.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)
Layer layer = mbtiles.getLayer(mbtiles.tiles(1))
```


| id | z | x | y |
|---|---|---|---|
| 0 | 1 | 0 | 0 |

| id | z | x | y |
|---|---|---|---|
| 1 | 1 | 1 | 0 |
| 2 | 1 | 0 | 1 |
| 3 | 1 | 1 | 1 |

## Using Tile Layers

Get a TileLayer and make sure it is closed when done.

```
File file = new File("src/main/resources/tiles.mbtiles")
TileLayer.withTileLayer(new MBTiles(file)) { TileLayer tileLayer ->
    println tileLayer.name
    println tileLayer.proj
    println tileLayer.bounds
}
```

```
countries
EPSG:3857
(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
```

## Get Tile Layer from a Map

Get an MBTiles TileLayer from a Map

```
TileLayer mbtiles = TileLayer.getTileLayer([type:'mbtiles', file:
'src/main/resources/tiles.mbtiles'])
println "${mbtiles.name} ${mbtiles.proj} ${mbtiles.bounds} ${mbtiles.pyramid}"
```

```
countries EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

Get an GeoPackage TileLayer from a Map

```
TileLayer geopackage = TileLayer.getTileLayer([type: 'geopackage', name: 'world',
file: 'src/main/resources/tiles.gpkg'])
println "${geopackage.name} ${geopackage.proj} ${geopackage.bounds}
${geopackage.pyramid}"
```

```
world EPSG:4326 (-179.99,-89.99,179.99,89.99,EPSG:4326)
geoscript.layer.Pyramid(proj:EPSG:4326, bounds:(-179.99,-
89.99,179.99,89.99,EPSG:4326), origin:TOP_LEFT, tileWidth:256, tileHeight:256)
```

Get an TMS TileLayer from a Map

```
TileLayer tms = TileLayer.getTileLayer([type: 'tms', file: 'src/main/resources/tms',
format: 'png', pyramid: 'globalmercator'])
println "${tms.name} ${tms.proj} ${tms.bounds} ${tms.pyramid}"
```

```
tms EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

Get an OSM TileLayer from a Map

```
TileLayer osm = TileLayer.getTileLayer([type: 'osm', url:
'http://a.tile.openstreetmap.org'])
println "${osm.name} ${osm.proj} ${osm.bounds} ${osm.pyramid}"
```

```
OSM EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:TOP_LEFT, tileWidth:256, tileHeight:256)
```

Get an PBF Vector TileLayer from a Map

```
TileLayer pbf = TileLayer.getTileLayer([type: 'vectortiles', name: 'world', file:
'src/main/resources/pbf', format: 'pbf', pyramid: 'GlobalMercator'])
println "${pbf.name} ${pbf.proj} ${pbf.bounds} ${pbf.pyramid}"
```

```
world EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

Get an UTF TileLayer from a Map

```
TileLayer utf = TileLayer.getTileLayer([type: 'utfgrid', file:
'src/main/resources/utf'])
println "${utf.name} ${utf.proj} ${utf.bounds} ${utf.pyramid}"
```

```
utf EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:TOP_LEFT, tileWidth:256, tileHeight:256)
```

## Get Tile Layer from a String

Get an MBTiles TileLayer from a String

```
TileLayer mbtiles = TileLayer.getTileLayer("type=mbtiles
file=src/main/resources/tiles.mbtiles")
println "${mbtiles.name} ${mbtiles.proj} ${mbtiles.bounds} ${mbtiles.pyramid}"
```

```
countries EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

Get an GeoPackage TileLayer from a String

```
TileLayer geopackage = TileLayer.getTileLayer("type=geopackage name=world
file=src/main/resources/tiles.gpkg")
println "${geopackage.name} ${geopackage.proj} ${geopackage.bounds}
${geopackage.pyramid}"
```

```
world EPSG:4326 (-179.99,-89.99,179.99,89.99,EPSG:4326)
geoscript.layer.Pyramid(proj:EPSG:4326, bounds:(-179.99,-
89.99,179.99,89.99,EPSG:4326), origin:TOP_LEFT, tileWidth:256, tileHeight:256)
```

Get an TMS TileLayer from a String

```
TileLayer tms = TileLayer.getTileLayer("type=tms file=src/main/resources/tms
format=png pyramid=globalmercator")
println "${tms.name} ${tms.proj} ${tms.bounds} ${tms.pyramid}"
```

```
tms EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

Get an OSM TileLayer from a String

```
TileLayer osm = TileLayer.getTileLayer("type=osm url=http://a.tile.openstreetmap.org")
println "${osm.name} ${osm.proj} ${osm.bounds} ${osm.pyramid}"
```

```
OSM EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:TOP_LEFT, tileWidth:256, tileHeight:256)
```

Get an PBF Vector TileLayer from a String

```
TileLayer pbf = TileLayer.getTileLayer("type=vectortiles name=world
file=src/main/resources/pbf format=pbf pyramid=GlobalMercator")
println "${pbf.name} ${pbf.proj} ${pbf.bounds} ${pbf.pyramid}"
```

```
world EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:BOTTOM_LEFT, tileWidth:256, tileHeight:256)
```

Get an UTF TileLayer from a String

```
TileLayer utf = TileLayer.getTileLayer("type=utfgrid file=src/main/resources/utf")
println "${utf.name} ${utf.proj} ${utf.bounds} ${utf.pyramid}"
```

```
utf EPSG:3857 (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
geoscript.layer.Pyramid(proj:EPSG:3857, bounds:(-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857),
origin:TOP_LEFT, tileWidth:256, tileHeight:256)
```

# TileRenderer

TileRenderers know how to create a Tile for a given Bounds. GeoScript has TileRenderer for creating images, vector tiles, and utfgrids.

## Get default TileRenderer

Get a default TileRenderer for a TileLayer

```
Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")
countries.style = new Fill("#ffffff") + new Stroke("#b2b2b2", 0.5)
Layer ocean = workspace.get("ocean")
ocean.style = new Fill("#a5bfdd")

TileLayer tileLayer = TileLayer.getTileLayer([type:'mbtiles', file:
'target/countries.mbtiles'])
TileRenderer tileRenderer = TileLayer.getTileRenderer(tileLayer, [ocean, countries])
Pyramid pyramid = tileLayer.pyramid
Tile tile = tileLayer.get(0,0,0)
Bounds bounds = pyramid.bounds(tile)
tile.data = tileRenderer.render(bounds)
tileLayer.put(tile)
```

## ImageTileRenderer

Use an ImageTileRenderer to create an image Tile.

```
Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")
countries.style = new Fill("#ffffff") + new Stroke("#b2b2b2", 0.5)
Layer ocean = workspace.get("ocean")
ocean.style = new Fill("#a5bfdd")

TileLayer tileLayer = TileLayer.getTileLayer([type:'mbtiles', file:
'target/countries.mbtiles'])
ImageTileRenderer tileRenderer = new ImageTileRenderer(tileLayer, [ocean, countries])
Pyramid pyramid = tileLayer.pyramid
Tile tile = tileLayer.get(0,0,0)
Bounds bounds = pyramid.bounds(tile)
tile.data = tileRenderer.render(bounds)
tileLayer.put(tile)
```

### RasterTileRenderer

Use an RasterTileRenderer to create a image Tiles from a single Raster.

```
File dir = new File("target/earthtiles")
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
TileLayer tileLayer = new TMS("Earth", "png", dir, pyramid)

Format format = new GeoTIFF(new File('src/main/resources/earth.tif'))
Raster raster = format.read()

// Resize and Reproject Raster to Web Mercator
Projection latLonProj = new Projection("EPSG:4326")
Projection mercatorProj = new Projection("EPSG:3857")
Bounds latLonBounds = new Bounds(-179.99, -85.0511, 179.99, 85.0511, latLonProj)
Raster webMercatorRaster = raster.resample(bbox: latLonBounds).reproject(mercatorProj)

RasterTileRenderer tileRenderer = new RasterTileRenderer(webMercatorRaster)
GeneratingTileLayer generatingTileLayer = new GeneratingTileLayer(tileLayer,
tileRenderer)
Tile tile = generatingTileLayer.get(0, 0, 0)
```

## VectorTileRenderer

Use an VectorTileRenderer to create a Vector Tile.

```
Workspace workspace = new Directory("src/main/resources/shapefiles")
Layer countries = workspace.get("countries")

File directory = new File("target/country_geojson_tiles")
directory.mkdir()

Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
VectorTiles tileLayer = new VectorTiles(
    "countries",
    directory,
    pyramid,
    "geojson"
)

GeoJSONWriter writer = new GeoJSONWriter()
VectorTileRenderer tileRenderer = new VectorTileRenderer(writer, countries, [
countries.schema.get("NAME")])
Tile tile = tileLayer.get(0,0,0)
Bounds bounds = pyramid.bounds(tile)
tile.data = tileRenderer.render(bounds)
tileLayer.put(tile)
```


```
{"type":"FeatureCollection","features":[{"type":"Feature","geometry":{"type":"MultiPol
ygon","coordinates":[[[[180,-16.0671],[180,-16.5552],[179.3641,-16.8014],[178.7251,-
17.012],[178.5968,-16.6392],[179.0966,-16.434],[179.4135,-16.3791],[180,-
16.0671]]],[[[178.1256,-17.5048],[178.3736,-17.3399],[178.7181,-17.6285],[178.5527,-
18.1506],[177.9327,-18.288],[177.3815,-18.1643],[177.285,-17.7246],[177.6709,-
17.3811],[178.1256,-17.5048]]],[[[-179.7933,-16.0209],[-179.9174,-16.5018],[-180,-
16.5552],[-180,-16.0671],[-179.7933,-
16.0209]]]]},"properties":{"NAME":"Fiji"},"id":"fid-68bb6f38_18b4a6db06a_-
73e1"},{"type":"Feature","geometry":{"type":"MultiPolygon","coordinates":[[[[33.9037,-
0.95],[34.0726,-1.0598],[37.6987,-3.097],[37.7669,-3.6771],[39.2022,-
4.6768],[38.7405,-5.9089],[38.7998,-6.4757],[39.44,-6.84],[39.47,-7.1],[39.1947,-
7.7039],[39.252,-8.0078],[39.1865,-8.4855],[39.5357,-9.1124],[39.9
```


## PbfVectorTileRenderer

Use an PbfVectorTileRenderer to create a Vector Tile.

```
Workspace workspace = new Directory("src/main/resources/shapefiles")
Layer countries = workspace.get("countries")

File directory = new File("target/country_pbf_tiles")
directory.mkdir()

Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
pyramid.origin = Pyramid.Origin.TOP_LEFT
VectorTiles tileLayer = new VectorTiles(
        "countries",
        directory,
        pyramid,
        "pbf"
)

PbfVectorTileRenderer tileRenderer = new PbfVectorTileRenderer(countries, [countries
.schema.get("NAME")])
Tile tile = tileLayer.get(0,0,0)
Bounds bounds = pyramid.bounds(tile)
tile.data = tileRenderer.render(bounds)
tileLayer.put(tile)
```

### UTFGridTileRenderer

Use an UTFGridTileRenderer to create a UTFGrid Tile.

```
Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")

File directory = new File("target/countryUtfGrid")
directory.mkdir()
UTFGrid tileLayer = new UTFGrid(directory)

UTFGridTileRenderer tileRenderer = new UTFGridTileRenderer(tileLayer, countries,
[countries.schema.get("NAME")])
Pyramid pyramid = tileLayer.pyramid
Tile tile = tileLayer.get(0,0,0)
Bounds bounds = pyramid.bounds(tile)
tile.data = tileRenderer.render(bounds)
tileLayer.put(tile)
```

```
{
    "grid": [
        "                                                                ",
        "                                                                ",
        "                                                                ",
        "                                                                ",
        "                  !     ###                                     ",
        "                !!!!!  #####                                    ",
        "               !!!!!#########                                   ",
        "              !!!!!!#########                 $                 ",
        "              !!!!!#########     %%%          $                 ",
        "            !  !!! #########     %%           $$                ",
        "           ! !! !!##########      %%           $                ",
        "          !  !!!!! #########      %       $    $$               ",
        "          !!!!!!!    #######                                    "
```

# TileCursor

A TileCursor is a way to get a collection of Tiles from a TileLayer.

Get a TileCursor with all of the Tiles from a TileLayer in a zoom level.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

long zoomLevel = 1
TileCursor tileCursor = new TileCursor(mbtiles, zoomLevel)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 1
# of tiles: 4
Bounds: (-2.003639514788131E7,-
2.0037471205137067E7,2.003639514788131E7,2.003747120513706E7,EPSG:3857)
Width / # Columns: 2
Height / # Rows: 2
MinX: 0, MinY: 0, MaxX: 1, MaxY: 1

Tiles:
Tile(x:0, y:0, z:1)
Tile(x:1, y:0, z:1)
Tile(x:0, y:1, z:1)
Tile(x:1, y:1, z:1)
```

Get a TileCursor with Tiles from a TileLayer in a zoom level between min and max x and y coordinates.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

long zoomLevel = 4
long minX = 2
long minY = 4
long maxX = 5
long maxY = 8
TileCursor tileCursor = new TileCursor(mbtiles, zoomLevel, minX, minY, maxX, maxY)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 4
# of tiles: 20
Bounds: (-1.5027296360910982E7,-1.0018735602568535E7,-
5009098.786970327,2504683.900642129,EPSG:3857)
Width / # Columns: 4
Height / # Rows: 5
MinX: 2, MinY: 4, MaxX: 5, MaxY: 8

Tiles:
Tile(x:2, y:4, z:4)
Tile(x:3, y:4, z:4)
Tile(x:4, y:4, z:4)
Tile(x:5, y:4, z:4)
Tile(x:2, y:5, z:4)
Tile(x:3, y:5, z:4)
Tile(x:4, y:5, z:4)
Tile(x:5, y:5, z:4)
Tile(x:2, y:6, z:4)
Tile(x:3, y:6, z:4)
Tile(x:4, y:6, z:4)
Tile(x:5, y:6, z:4)
Tile(x:2, y:7, z:4)
Tile(x:3, y:7, z:4)
Tile(x:4, y:7, z:4)
Tile(x:5, y:7, z:4)
Tile(x:2, y:8, z:4)
Tile(x:3, y:8, z:4)
Tile(x:4, y:8, z:4)
Tile(x:5, y:8, z:4)
```

Get a TileCursor with Tiles from a TileLayer in a zoom level for a given Bounds.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

Bounds bounds = new Bounds(-102.875977, 45.433154, -96.481934, 48.118434,
"EPSG:4326").reproject("EPSG:3857")
int zoomLevel = 8
TileCursor tileCursor = new TileCursor(mbtiles, bounds, zoomLevel)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 8
# of tiles: 24
Bounds: (-1.1583540944868883E7,5635538.7764447965,-
1.0644334922311947E7,6261709.751605326,EPSG:3857)
Width / # Columns: 6
Height / # Rows: 4
MinX: 54, MinY: 164, MaxX: 59, MaxY: 167

Tiles:
Tile(x:54, y:164, z:8)
Tile(x:55, y:164, z:8)
Tile(x:56, y:164, z:8)
Tile(x:57, y:164, z:8)
Tile(x:58, y:164, z:8)
Tile(x:59, y:164, z:8)
Tile(x:54, y:165, z:8)
Tile(x:55, y:165, z:8)
Tile(x:56, y:165, z:8)
Tile(x:57, y:165, z:8)
Tile(x:58, y:165, z:8)
Tile(x:59, y:165, z:8)
Tile(x:54, y:166, z:8)
Tile(x:55, y:166, z:8)
Tile(x:56, y:166, z:8)
Tile(x:57, y:166, z:8)
Tile(x:58, y:166, z:8)
Tile(x:59, y:166, z:8)
Tile(x:54, y:167, z:8)
Tile(x:55, y:167, z:8)
Tile(x:56, y:167, z:8)
Tile(x:57, y:167, z:8)
Tile(x:58, y:167, z:8)
Tile(x:59, y:167, z:8)
```

Get a TileCursor with Tiles from a TileLayer in a zoom level for a given x and y resolution.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

Bounds bounds = new Bounds(-124.73142200000001, 24.955967, -66.969849, 49.371735,
"EPSG:4326").reproject("EPSG:3857")
double resolutionX = bounds.width / 400
double resolutionY = bounds.height / 300
TileCursor tileCursor = new TileCursor(mbtiles, bounds, resolutionX, resolutionY)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 4
# of tiles: 8
Bounds: (-1.5027296360910982E7,2504683.9006421305,-
5009098.786970327,7514051.701926393,EPSG:3857)
Width / # Columns: 4
Height / # Rows: 2
MinX: 2, MinY: 9, MaxX: 5, MaxY: 10

Tiles:
Tile(x:2, y:9, z:4)
Tile(x:3, y:9, z:4)
Tile(x:4, y:9, z:4)
Tile(x:5, y:9, z:4)
Tile(x:2, y:10, z:4)
Tile(x:3, y:10, z:4)
Tile(x:4, y:10, z:4)
Tile(x:5, y:10, z:4)
```

Get a TileCursor with Tiles from a TileLayer within a Bounds for a given canvas width and height.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

Bounds bounds = new Bounds(-102.875977, 45.433154, -96.481934, 48.118434,
"EPSG:4326").reproject("EPSG:3857")
int width = 400
int height = 400
TileCursor tileCursor = new TileCursor(mbtiles, bounds, width, height)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 7
# of tiles: 6
Bounds: (-1.1583540944868883E7,5635538.7764447965,-
1.0644334922311947E7,6261709.751605329,EPSG:3857)
Width / # Columns: 3
Height / # Rows: 2
MinX: 27, MinY: 82, MaxX: 29, MaxY: 83

Tiles:
Tile(x:27, y:82, z:7)
Tile(x:28, y:82, z:7)
Tile(x:29, y:82, z:7)
Tile(x:27, y:83, z:7)
Tile(x:28, y:83, z:7)
Tile(x:29, y:83, z:7)
```

Get a TileCursor with Tiles from a TileLayer around a Point at a given zoom level for a given canvas width and height.

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)

Bounds bounds = new Bounds(-102.875977, 45.433154, -96.481934, 48.118434,
"EPSG:4326").reproject("EPSG:3857")
int width = 400
int height = 400
TileCursor tileCursor = new TileCursor(mbtiles, bounds, width, height)

println "Zoom Level: ${tileCursor.z}"
println "# of tiles: ${tileCursor.size}"
println "Bounds: ${tileCursor.bounds}"
println "Width / # Columns: ${tileCursor.width}"
println "Height / # Rows: ${tileCursor.height}"
println "MinX: ${tileCursor.minX}, MinY: ${tileCursor.minY}, MaxX: ${tileCursor.maxX},
MaxY: ${tileCursor.maxY}"

println "Tiles:"
tileCursor.each { Tile t ->
    println t
}
```

```
Zoom Level: 7
# of tiles: 6
Bounds: (-1.1583540944868883E7,5635538.7764447965,-
1.0644334922311947E7,6261709.751605329,EPSG:3857)
Width / # Columns: 3
Height / # Rows: 2
MinX: 27, MinY: 82, MaxX: 29, MaxY: 83

Tiles:
Tile(x:27, y:82, z:7)
Tile(x:28, y:82, z:7)
Tile(x:29, y:82, z:7)
Tile(x:27, y:83, z:7)
Tile(x:28, y:83, z:7)
Tile(x:29, y:83, z:7)
```

# TMS

Access a TileLayer from an TMS directory

```
File dir = new File("src/main/resources/tms")
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
TMS tms = new TMS(
    "world", ①
    "png",   ②
    dir,     ③
    pyramid  ④
)
```

① Name

② Image type

③ Directory

④ Pyramid

# MBTiles

Access a TileLayer from an MBTiles file

```
File file = new File("src/main/resources/tiles.mbtiles")
MBTiles mbtiles = new MBTiles(file)
```

# DBTiles

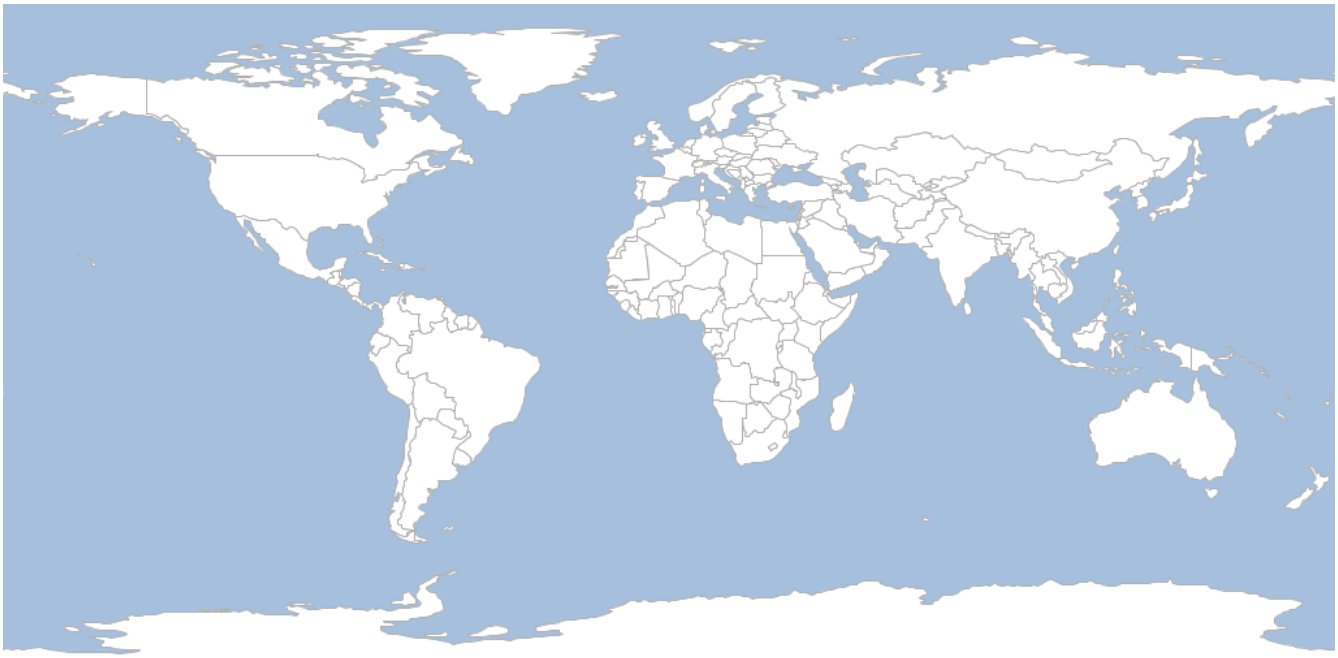
Access a TileLayer from an DBTiles H2 database

```
File file = new File("src/main/resources/h2dbtiles/world_tiles.db")
DBTiles dbtiles = new DBTiles("jdbc:h2:${file}","org.h2.Driver", "World", "World wide tiles")
```

## GeoPackage

Access a TileLayer with a Global Geodetic Pyramid from an GeoPackage file

```
File file = new File("src/main/resources/data.gpkg")
geoscript.layer.GeoPackage geopackage = new geoscript.layer.GeoPackage(file, "world")
```



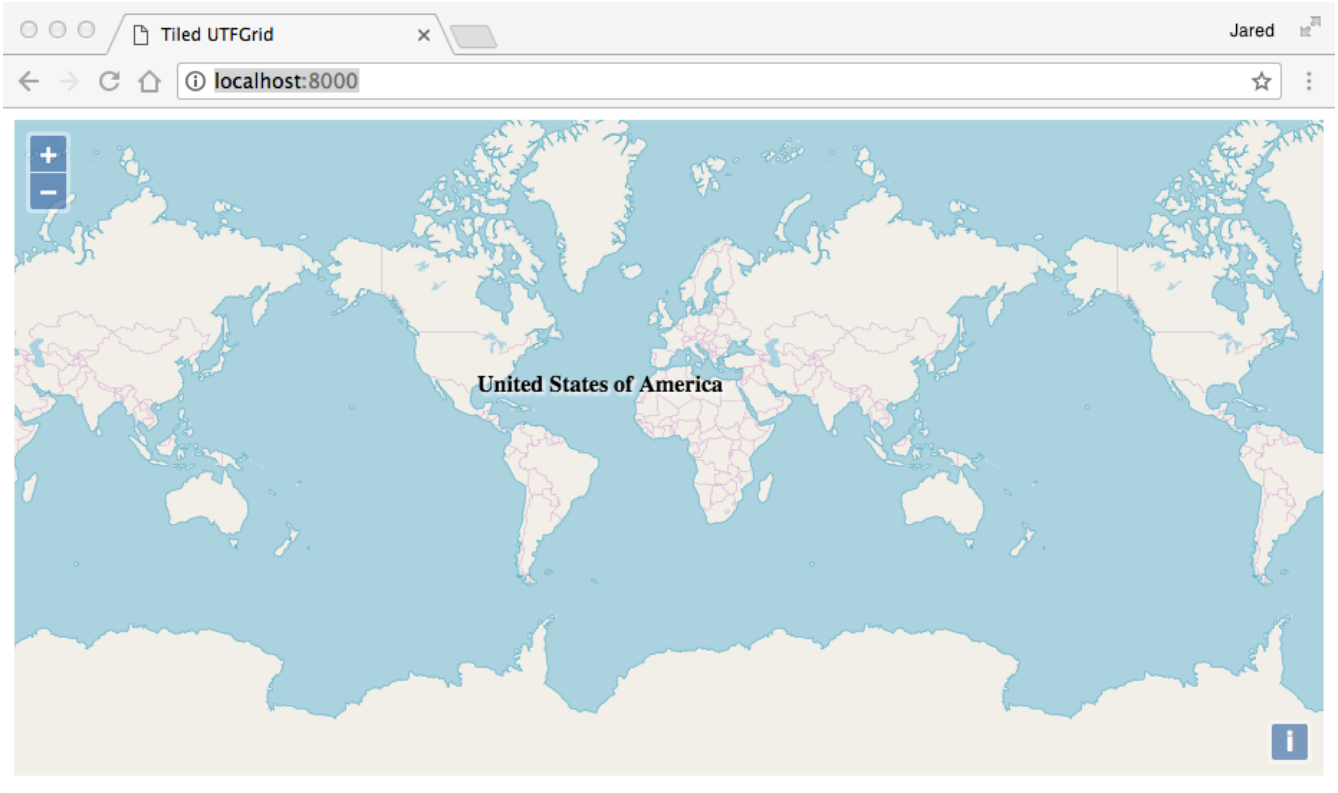
Access a TileLayer with a Global Mercator Pyramid from an GeoPackage file

```
File file = new File("src/main/resources/data.gpkg")
geoscript.layer.GeoPackage geopackage = new geoscript.layer.GeoPackage(file,
"world_mercator")
```

# UTFGrid

Access a TileLayer from an UTFGrid directory

```
File dir = new File("src/main/resources/utf")
UTFGrid utfGrid = new UTFGrid(dir)
```




# VectorTiles

Access a TileLayer from an VectorTiles directory

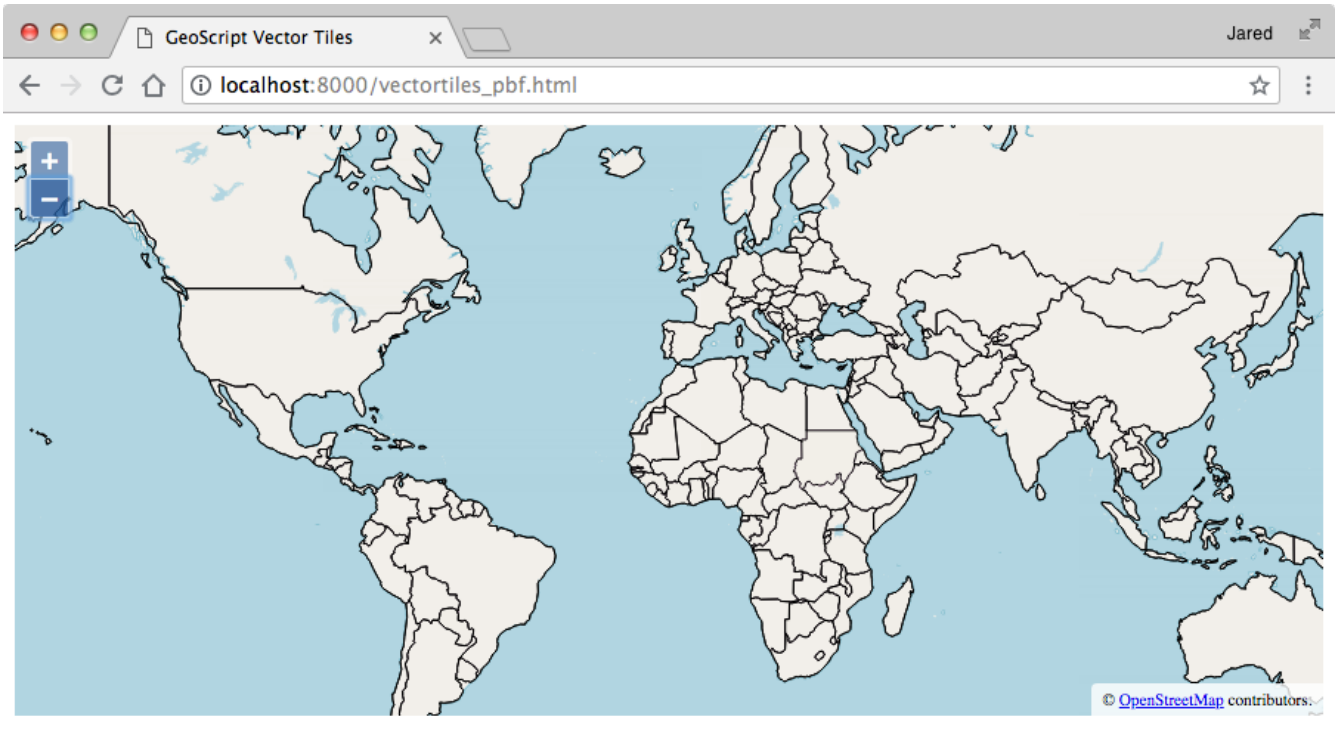
```
File dir = new File("src/main/resources/pbf")
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
VectorTiles vectorTiles = new VectorTiles(
    "World",  ①
    dir,      ②
    pyramid,  ③
    "pbf"     ④
)
```

① Name

② Directory

③ Pyramid

④ Type




Access a TileLayer from an VectorTiles MBTiles file

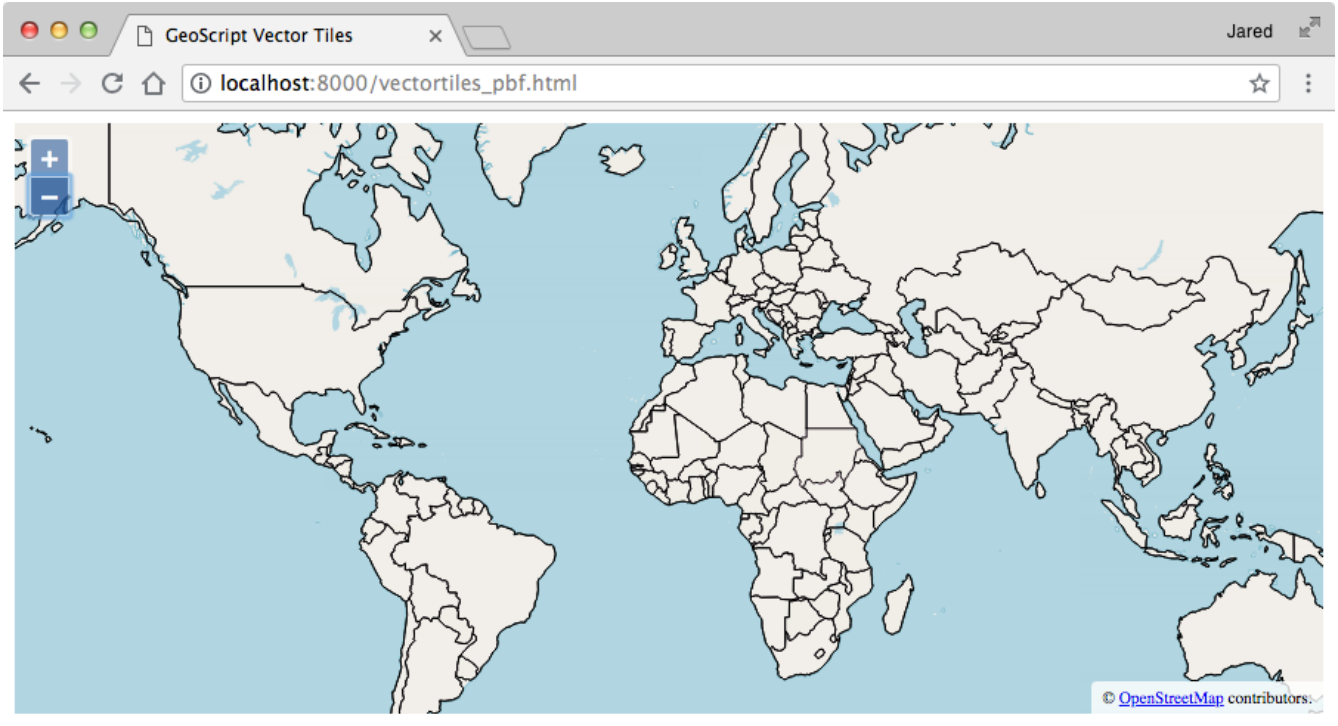
```
File file = new File("src/main/resources/vectortiles.mbtiles")
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
VectorTiles vectorTiles = new VectorTiles(
        "World",  ①
        file,     ②
        pyramid,  ③
        "pbf"     ④
)
```

① Name

② MBTiles File

③ Pyramid

④ Type




# Generating TileLayer

A GeneratingTileLayer can create tiles on demand when they are accessed.

```
File dir = new File("target/worldtiles")
Pyramid pyramid = Pyramid.createGlobalMercatorPyramid()
TileLayer tileLayer = new TMS("World", "png", dir, pyramid)

Workspace workspace = new GeoPackage('src/main/resources/data.gpkg')
Layer countries = workspace.get("countries")
countries.style = new Fill("#ffffff") + new Stroke("#b2b2b2", 0.5)
Layer ocean = workspace.get("ocean")
ocean.style = new Fill("#a5bfdd")
TileRenderer tileRenderer = new ImageTileRenderer(tileLayer, [ocean, countries])

GeneratingTileLayer generatingTileLayer = new GeneratingTileLayer(tileLayer,
tileRenderer)
Tile tile = generatingTileLayer.get(0, 0, 0)
```

## OSM

Create a TileLayer for OSM tiles.

```
OSM osm = new OSM()
```

Create a TileLayer for OSM tiles with custom urls.

```
OSM osm = new OSM("OSM", [
    "http://a.tile.openstreetmap.org",
    "http://b.tile.openstreetmap.org",
    "http://c.tile.openstreetmap.org"
])
```

### Standard OSM

Create a TileLayer for OSM tiles.

```
OSM osm = OSM.getWellKnownOSM("osm")
```

### Stamen Toner

Create a TileLayer for OSM Stamen Toner tiles.

```
OSM osm = OSM.getWellKnownOSM("stamen-toner")
```

### Stamen Toner Lite

Create a TileLayer for OSM Stamen Toner Lite tiles.

```
OSM osm = OSM.getWellKnownOSM("stamen-toner-lite")
```

### Stamen Water Color

Create a TileLayer for OSM Stamen Water Color tiles.

```
OSM osm = OSM.getWellKnownOSM("stamen-watercolor")
```

### Stamen Terrain

Create a TileLayer for OSM Stamen Terrain tiles.

```
OSM osm = OSM.getWellKnownOSM("stamen-terrain")
```

### WikiMedia

Create a TileLayer for OSM WikiMedia tiles.

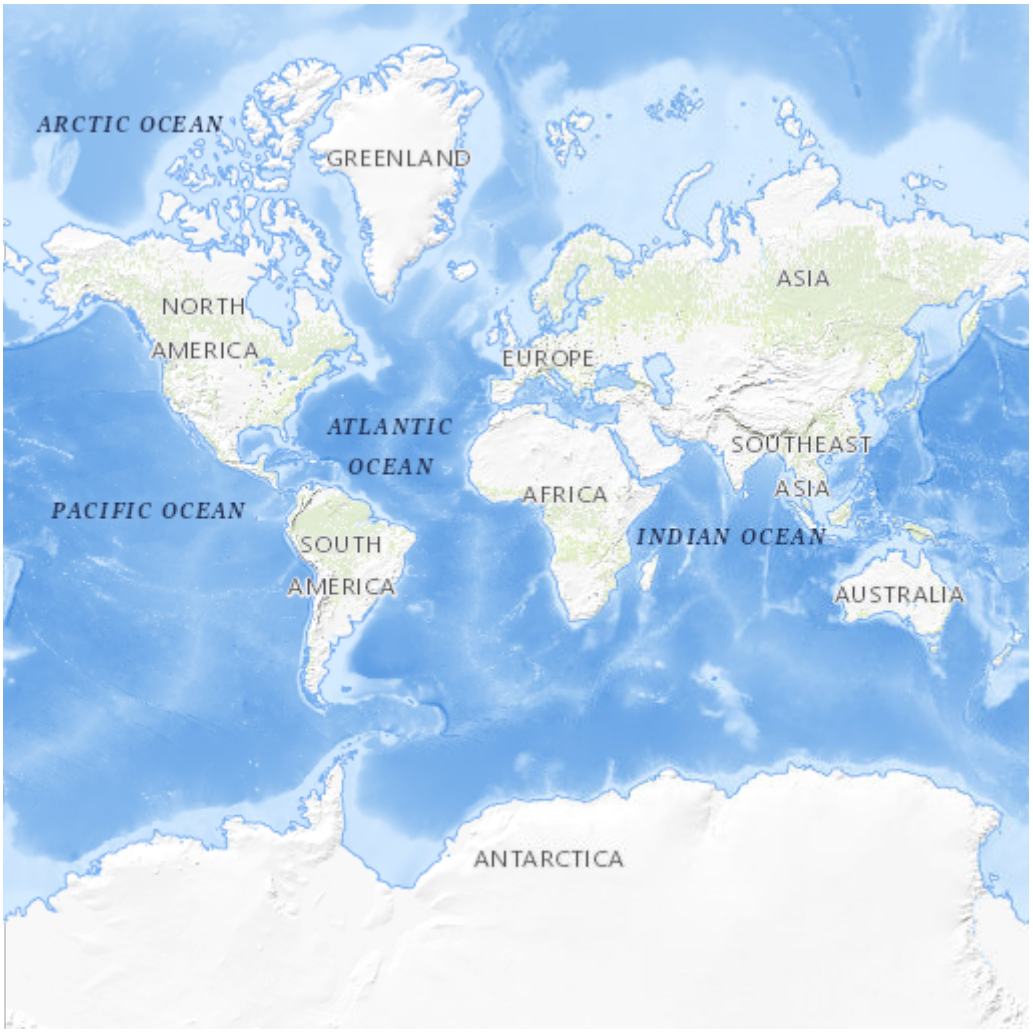
```
OSM osm = OSM.getWellKnownOSM("wikimedia")
```

## USGS National Map

Create a TileLayer for USGS National Map tiles.

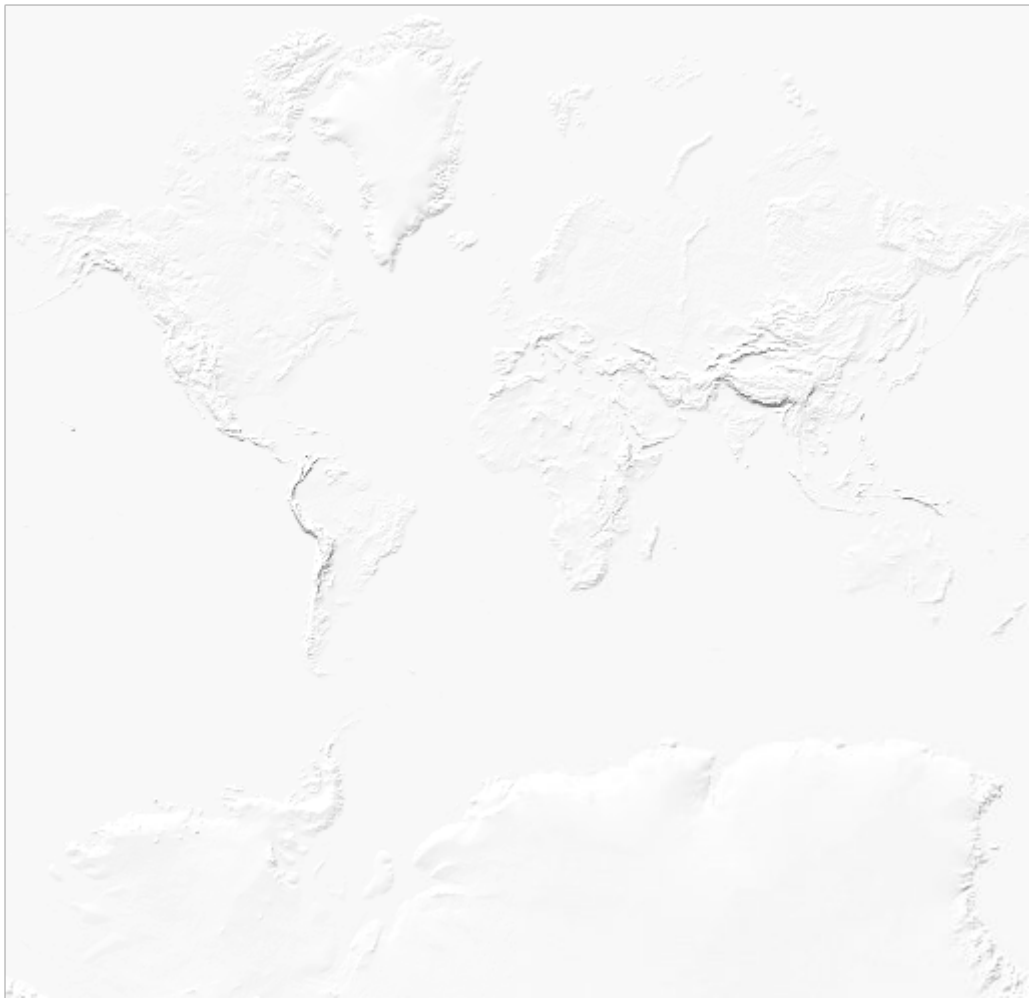
### Topo

```
USGSTileLayer tileLayer = USGSTileLayer.getWellKnown("usgs-topo")
```



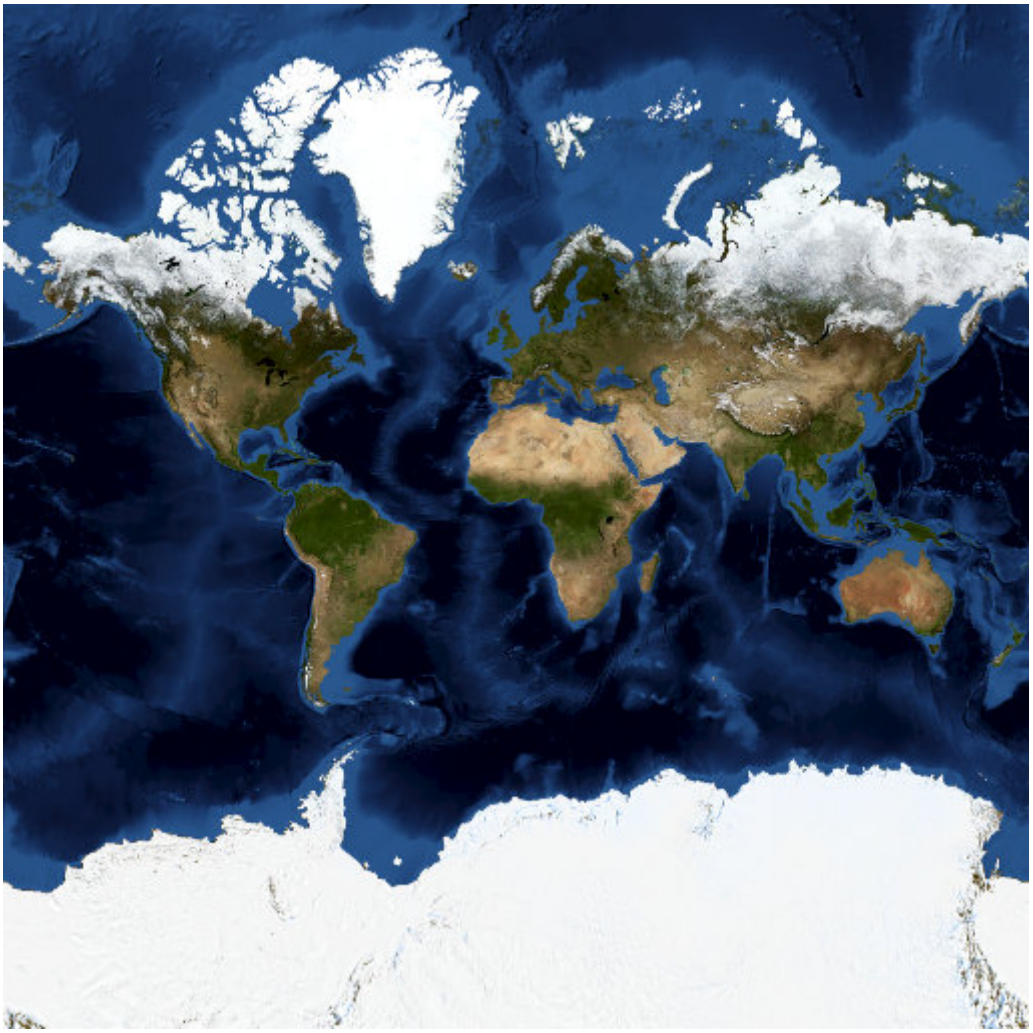

**Shaded Relief**

```
USGSTileLayer tileLayer = USGSTileLayer.getWellKnown("usgs-shadedrelief")
```



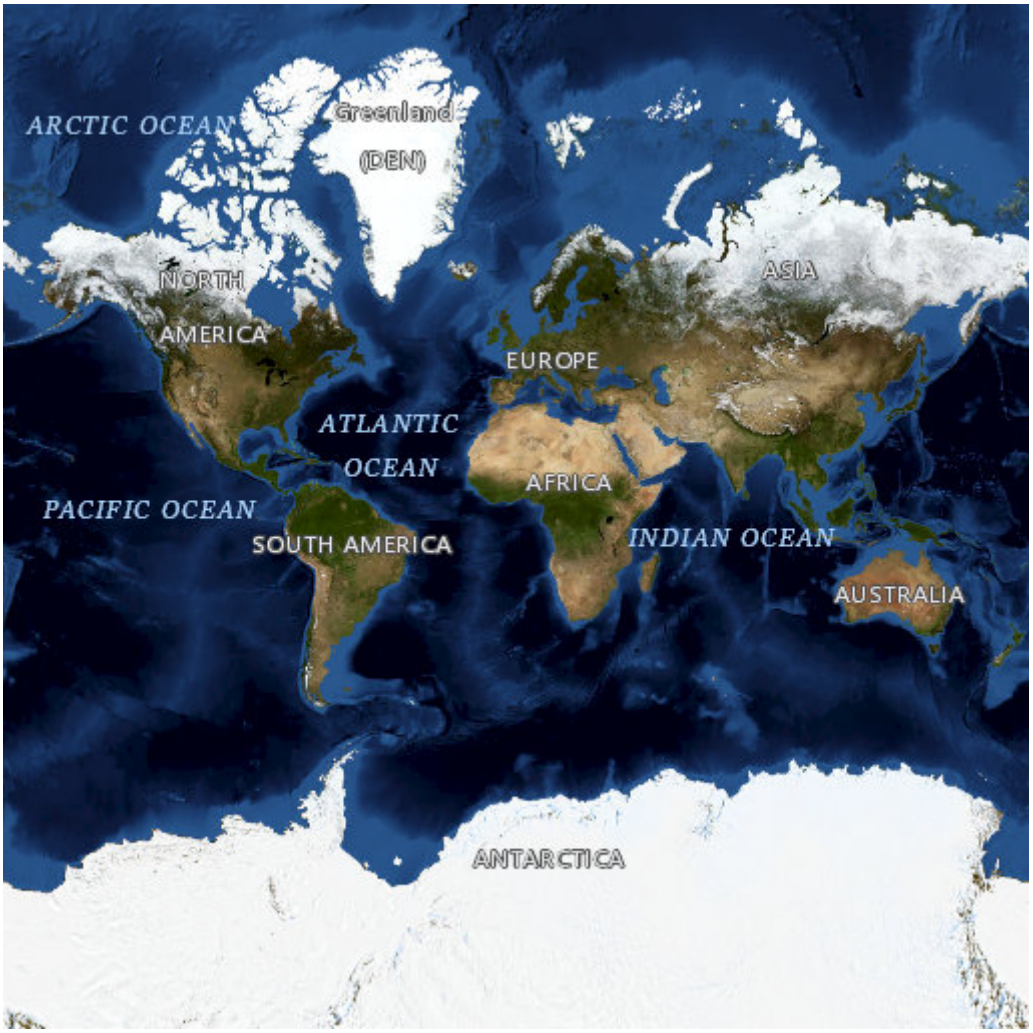
### Imagery

```
USGSTileLayer tileLayer = USGSTileLayer.getWellKnown("usgs-imagery")
```



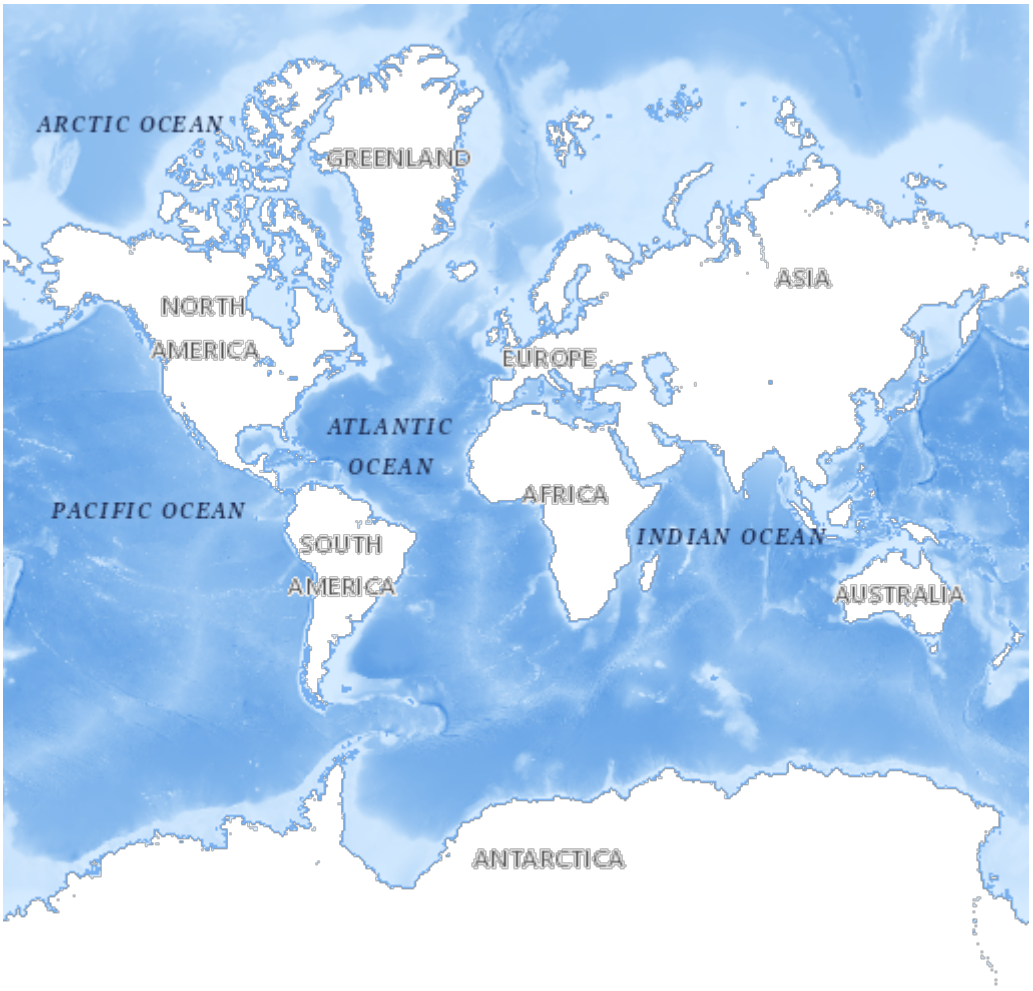
### Imagery & Topo

```
USGSTileLayer tileLayer = USGSTileLayer.getWellKnown("usgs-imagerytopo")
```




### Hydro

```
USGSTileLayer tileLayer = USGSTileLayer.getWellKnown("usgs-hydro")
```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