GEOLOGY OF THE BLACK ROCK DESERT

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BURNING MAN EARTH GUARDIANS PAVILION 2012

LEAVE NO TRACE

Please come find me and I’ll give you a personal tour of the posters!
You are here! In one of the most amazing geologic wonderlands in the world!

Fantastic rock exposure, spectacular geomorphic features, and a long history, including:

1. PreCambrian loss of our Australian neighbors by continental rifting,
2. Paleozoic accretion of island volcanic chains like Japan (twice!),
3. Mesozoic compression and emplacement of a batholith,
4. Cenozoic stretching and volcanism, plus a mantle plume torching the base of the continent!
Let’s start with what you can see on the playa and from the playa: the Neogene to Recent geology, which is the past ~23 million years (= Ma).

Note: Recent = past 15,000 years
Then we’ll “build” the terrane you are standing on, beginning with a **BILLION** years ago, moving through the **Paleozoic** (old life, ~540-253 Ma),

**Mesozoic** (age of dinosaurs, ~253-65 Ma)) and

**Cenozoic** (age of mammals, ~65 -0 Ma).

<table>
<thead>
<tr>
<th>Eon</th>
<th>Era</th>
<th>Period</th>
<th>Millions of years ago</th>
<th>Major appearances</th>
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Black Rock Playa extends 100 miles, from Gerlach to the Jackson Mountains.

The Black Rock Desert is divided into two arms by the Black Rock Range, and covers 1,000 square miles.

Empire (south of Gerlach) has the U.S. Gypsum mine and drywall factory (brand name "Sheetrock"), and there's an opal mine at base of Calico Mtns.
BRP = The largest playa in North America

“Playa” = a flat-bottomed depression, usually a dry lake bed

3,500’ asl in SW, 4,000’ asl in N

Land speed record: 1997 - supersonic car, 766 MPH

Runoff mainly from the Quinn River, which heads in Oregon ~150 miles north.
>15,000 years (Recent) ago the Humboldt River flowed into north Lake Lahontan, but since that dried up, the river has diverted south to the Carson Desert sub-basin (Carson Sink). Earliest humans here lived on the Lahontan lake shores.

Lake Lahontan was 500’ deep in the Black Rock Desert, and 900’ deep at present-day Pyramid Lake. Walker Lake also survives. Lake Lahontan dried up due to increased evaporation as the climate warmed.
Neogene to Recent geology

The highest lake level reached an elevation of about 4370 feet above sea level, evidenced by a wave-built terrace of unsorted gravel called Lahontan Beach. This photo shows numerous flat-lying shoreline deposits. You can also see these at the south end of Death Valley, which held Lake Manly.

View 11 miles north of Gerlach on road 34. Playa is to right. Photo by M. Bilbo.
The highest Lahontan Lake levels are also recorded by the “High-Dry” micro-playas just east of the Black Rock (Black Rock hot springs on basin floor in front).

These are perfect, beautiful little playas!

Top photo by Delores Cates, bottom photo by Mike Bilbo.
Over the past ~25 million years (Neogene), the crust has been stretched or rifted.

That makes grabens drop down in between horst blocks, along normal faults.

The playa is in a graben. Nevada has a whole series, called the “Basin and Range”.
Hot springs of the Black Rock Desert form where hot water comes up along the faults that make the grabens.
Cartoon view of a typical rift basin: A high mountain range comes up, next to a basin that sinks along the normal fault. Alluvial fans build out from the mountain front into the basin, and the center of the basin fills with lake sediment.

From Tectonics of Sedimentary Basins edited by Busby and Ingersoll (1995)
Cross section of a **typical rift basin**: thousands of feet of lacustrine silt and clay, with alluvial fans on basin margin. This example is actually from the East African Rift.

BIG PICTURE
TECTONIC SETTING:

Nevada is outlined in yellow.

Ranges of the Basin and Range look like “worms crawling north to Canada” =

ALL NORMAL FAULTS.
BIG PICTURE TECTONIC SETTING - Stretching of Basin and Range, also Rio Grande Rift. The Colorado Plateau in between is too strong to stretch!
Neogene to Recent geology, continued

BIG PICTURE TECTONIC SETTING

We’re on the North American Plate in the Basin and Range, but we’re close to the eastern edge of the Sierran Microplate, which has \textbf{strike slip faults} (as well as normal faults) that are parallel to the San Andreas Fault = \textbf{WALKER LANE BELT}

(from Unruh et al., 2003)
Most of the Basin and range is now tectonically dead but the Walker Lane belt is seismically active (dots = earthquakes).
The Neogene (~23 Ma-present) stretching of Nevada is very obvious on the geologic map.

But now let’s see how our corner of Nevada has been constructed over the past billion years, starting with the oldest rocks and working toward the Recent.

Black Rock Desert, from a billion years to now.
Black Rock Desert, *from a billion years to now.*

Quaternary sediments and volcanic rocks (<2.6 Ma)

Miocene-Pliocene volcanic and sedimentary rocks

Oligocene volcanic rocks

Mesozoic strata and intrusions

Upper Paleozoic accreted oceanic rocks

Lower Paleozoic: accreted continental margin

NO PRECAMBRIAN HERE
Rocks from other parts of Nevada show that, a billion years ago, Gondwana (Australia and Antarctica) rifted westward off Nevada and an ocean opened in between.
By Early Paleozoic time (~650 - 450 Ma), an “Atlantic-type” passive margin developed, with a broad continental shelf, and warm water (see outline of Nevada).
Paleozoic sedimentary rocks host the “Carlin-type gold deposits”, produced by hydrothermal circulation of hot water through them.

Nevada has the largest gold deposit of this type in the world!

The origin of the heat source for the “Carlin Trend” remains controversial.
Paleozoic sedimentary rocks deposited on the broad continental shelf are mainly bedded limestones and mudstone. They got folded during the mountain building events (orogenies) in the Late Paleozoic to Mesozoic.
Black Rock Desert, from a billion years to now.

Somewhere offshore of the broad early Paleozoic shelf, an oceanic arc a formed above a subduction zone (see next).
Black Rock Desert, from a billion years to now.

An “arc” is a chain of volcanoes that from above a subduction zone.

Arcs may form islands that lie offshore of a continent like Japan (shown at top )
or they may form above sea level on continental crust (shown at bottom, like the Cascade volcanoes today).
In Middle Paleozoic time, the oceanic/island arc approached and then got pushed up onto Nevada along **THRUST FAULTS**, causing the **Antler Orogeny** (~370 to 340 Ma).

Then in Late Paleozoic time, the same thing happened all over again with a different arc, causing the **Sonoma Orogeny** (~ 250 Ma).
The Black Rock is part of the “Sonomia” oceanic rock assemblage. It is Permian volcanic rock - probably a shallow intrusion, not a lava flow.
All through the Mesozoic Era (~251 to 65 Ma), subduction occurred under the edge of the continent, forming a continental arc. This produced the great batholiths of western North America, which got exposed by uplift and erosion of the volcanic cover.
During the Mesozoic, the subducting slab got shallower and shallower, until it was grinding along the base of the continent.

This caused compression of the continent, causing uplift (orogeny), and erosion of the volcanic rocks arc to expose the batholith below.
The Mesozoic batholiths are thus the deeply-eroded roots of the Mesozoic subduction volcanoes.

Big pink feldspars in a granite, typical of the batholithic rocks.
In Oligocene time (~34-23 Ma), giant continental calderas produced SUPERVOLCANOES.

**Supervolcanoes** produce gigantic, highly explosive eruptions.

*Black Rock Desert, from a billion years to now, continued.*
Miocene-Pliocene volcanic and sedimentary rocks

In Miocene and Pliocene time (~23 to 2.5 Ma), Basin and Range Extension was in fill swing! Grabens filled with volcanic and sedimentary rocks.

Black Rock Desert, from a billion years to now, continued.
Stretching of the continental crust produced the **Lahonton Basin**, ultimately giving us our playa!

(from Catchings, 1992).
Cross section through Black Rock Range (BRR), Pinto Mountain (PM), Black Rock Desert (BRD), and Jackson Mountains (west to east). Shown to a depth of 12 km.

From Lerch et al. 2008. NOTE: the second author of this paper is a Burner. Can anyone guess who she is?????
Vapid Transit  by Elizabeth Miller, Dwight Harbough & Clay Hamilton
Black Rock Desert, from a billion years to now, continued.

NOTE ALSO:
Some of the volcanic rocks (orange) are related to the Yellowstone hot spot track........
Yellowstone hot spot track: an eastward-migrating series of giant continental calderas (16 Ma in west, Yellowstone in east).

Also

MOP = Modoc Plateau,
a mile-high lava plateau.
Thank you for your interest and have a good burn!

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