The Stuff We're Made Of

Kimbel Westerson

I INSIST ON A WINDOW SEAT WHEN I FLY, fascinated with the landscape below revealed from 30,000 feet. The Midwest, my original home, looks like a quilt, its squares green, brown, gold, and black soil that is sediment, the circumstantial evidence of a prehistoric lake. Heading west, past the point where rainfall diminishes and the land is range rather than prairie, past the 100th Meridian into the West, landscape gives way from square fields, some with round green centers, the product of center point irrigation, to muted desert landscape. From above, the Colorado Plateau is a bleached surface veined with red, brown, and black spiny mountain ranges and incised canyons, its topography flattened by the perspective of altitude. This is the earth as abstract; a cracked rough plaster tile.

At ground level, those spines and vessels become familiar. Movie star Monument Valley, the maligned and admired Little Colorado River, the Grand Canyon, ghostly Book Cliffs, Black Canyon of the Gunnison, the Colorado that Powell navigated, writing of a "poverty of sky" as the canyons closed in. Loosely bound by scrunched up mountain ranges, the science of the Colorado Plateau is about faulting, volcanic activity, and erosion. But its place names are poetry—Uinta, Wasatch, San Juan, LaPlata. Within them, more poetry: Uncompahgre, Defiance, The Great Unconformity—the even more vivid Supercrack.

Focus in tighter, to a geological level. Look at land that has been formed and reformed, torn, twisted, and contorted. This rock reveals fossilized shells, mammoth skeletons, pollen, showing that not only has the landscape profoundly changed, the climate has, too. Look past the calendar-quality mountain and canyon desertscapes to the materials that have arranged themselves to form them. In geological circles, the word dirt is not used—it's too vague for science. (According to one geologist I spoke with, the word "dirt" might be used in reference to a bad research paper.) The real story here is one of sediment made of eroded materials, periods of deposition and re-deposition over millions of years.

Trace the Grand Staircase of the western plateau from the bottom of the Grand Canyon all the way to Bryce Canyon. Of course, all 15,000 feet of that layer can't be seen at the same time in any one place over those hundred-odd miles. But underfoot and overhead along the way, a large chunk of the geologic history unfolds. In the gorge at the deepest point of the Grand Canyon is Vishnu Schist, dark basement rock from Earth's crust. Rocks of a similar period show up around the plateau. The Black Canyon of the Gunnison, at the

The real story here is one of sediment made of eroded materials, periods of deposition and re-deposition over millions of years.

FACING: Dry Colorado River below Algodones, Mexico, near Yuma, AZ. Photo by Michael Collier.

It takes very little iron (1 per cent or less) to coat grains of sandstone.

Once exposed to water and oxygen, they turn deep red. Rust happens. And it's pretty.

northernmost edge of the plateau, contains rocks of correlative age to those in the bottom of the canyon, a glorious example of granite heated, compressed and recrystallized; gneiss streaked with light bands of feldspar and quartz, and dark bands of quartz and mica.

A few layers above are layers of Coconino Sandstone, its white and buff color startling against darker minerals. Deposited about 275 million years ago, its color is from fine quartz grains. Above that, also buff or white, is Kaibab Limestone, marine limestone that was sediment deposited in a massive inland sea that covered the southern two-thirds of the plateau. This is where marine fossils show up that prove the marine origins.

The showy, brilliant vermillion rocks, signature of so many canyons in the plateau, showed up in the Triassic and Jurassic periods, a mere 250 to 200 million years ago. We recognize this throughout the entire plateau, the photogenic red rock beds that are the product of sand, mud, gravel, boulders, and silt washed across from the Uncompahgre uplands. Most of these were high in feldspar content and chlorite and gave a pinkish cast to rocks. Minerals that contain high iron, magnesium and silicates were also deposited, but were more susceptible to chemical weathering and decomposed to release their iron content into ground waters. Iron acts as a stain or a red matrix between other grains, resulting in reddish sandstones, mudstones, and shales. It takes very little iron—1 per cent or less—to coat grains of sandstone. Once exposed to water and oxygen, they turn deep red. Rust happens. And it's pretty.

Navajo Sandstone, the white layer of rock that's found in abundance in Zion National Park—up to 2,500 feet thick in places—is evidence of the massive sand sea that encroached and receded across Utah and northern Arizona. The dry sea bed was largely flat and wind carried the sand into greater and greater deposits. Navajo Sandstone shows up in other colors, too, depending upon the proportions of other minerals present: black, brown, salmon, pink, peach, yellow.

Sheets of cross-bedded Esplanade Sandstone at river mile 15 in Marble Canyon, AZ. Photo by Bronze Black.

A summer storm pounds Zion National Park, UT. Photo by David Welling.

Where the minerals go, color follows. Petrified wood absorbed iron contained in the silica that turned the cellulose to stone, showing up red and brown. Copper in the mix produced greens and blues. And water sources are transformed by mineral content, too. In August 1869, members of the John Wesley Powell expedition, George Bradley and Jack Sumner, called the Little Colorado River "…a lo[a]thesome little stream, so filthy and muddy that it fairly stinks." They were probably viewing the river after a period of flash flooding, its sediment settling down into a muddy layer. Most of the time, the same stream appears blue, a result of a high concentration of travertine limestone and calcium carbonate in the water. The Colorado River is generally true to its name until its waters lose momentum and drop their sediment in the manmade reservoirs that dot its mainstem. Emerging once again from these dams, the waters have been transformed from reddish brown to emerald green.

The Basin and Range Province to the west holds the most precious mineral wealth—copper in particular—quartz in abundance, and some gemstones. The Rocky Mountains hold the lodes of gold, even though it has been rumored that the western slope of Colorado's La Plata range holds an array of mineral deposits, including gold. One of the most recent gold rushes happened there in 1934, and amateur prospectors still look for fabled veins. The Colorado Plateau Province holds its share of fossil fuels—oil shale and coal. But any look at minerals on the plateau must include uranium.

Now move past economics, beyond science. Imagine these minerals coalescing, being shaped into new forms that walk and live and breathe and explain their very existence in terms of Earth.

The mineral originates as the product of exploding stars, or supernovae, which our solar system inherited from many, many others. (Ironically, the uranium-to-lead decay rate is one of the ways of measuring time that has helped scientists determine exactly when these episodes happened.) On Earth, eighteenth-century German miners called it pitchblende—pitch for black, and blende to indicate a combination of minerals. The mineral was uraninite. Marie Curie used pitchblende to separate the mineral radium, and died of aplastic anemia, probably a result of exposure to radioactivity. And until World War II, radium was the element in demand as the stuff put in luminous paint that made watch dials glow. The weapons industry changed all that, and the need for cheap electricity changed it again.

The history of uranium mining in the province goes back more than 100 years. Unlike igneous or vein deposits, Colorado Plateau deposits of uranium ore can be spotted in some places quite easily: sedimentary rock, specifically sandstone with alternating red and greenish-white striations. Once mined, chunks of ore show yellowish green, nearly neon. Sedimentary deposits close to the surface are attractive because the mineral is more easily and cheaply mined. The Salt Wash member of the Morrison Formation is the site of great uranium deposits in western Colorado, southeastern Utah, northeastern Arizona and northwestern New Mexico—also sometimes referred to as the Uravan Mineral Belt.

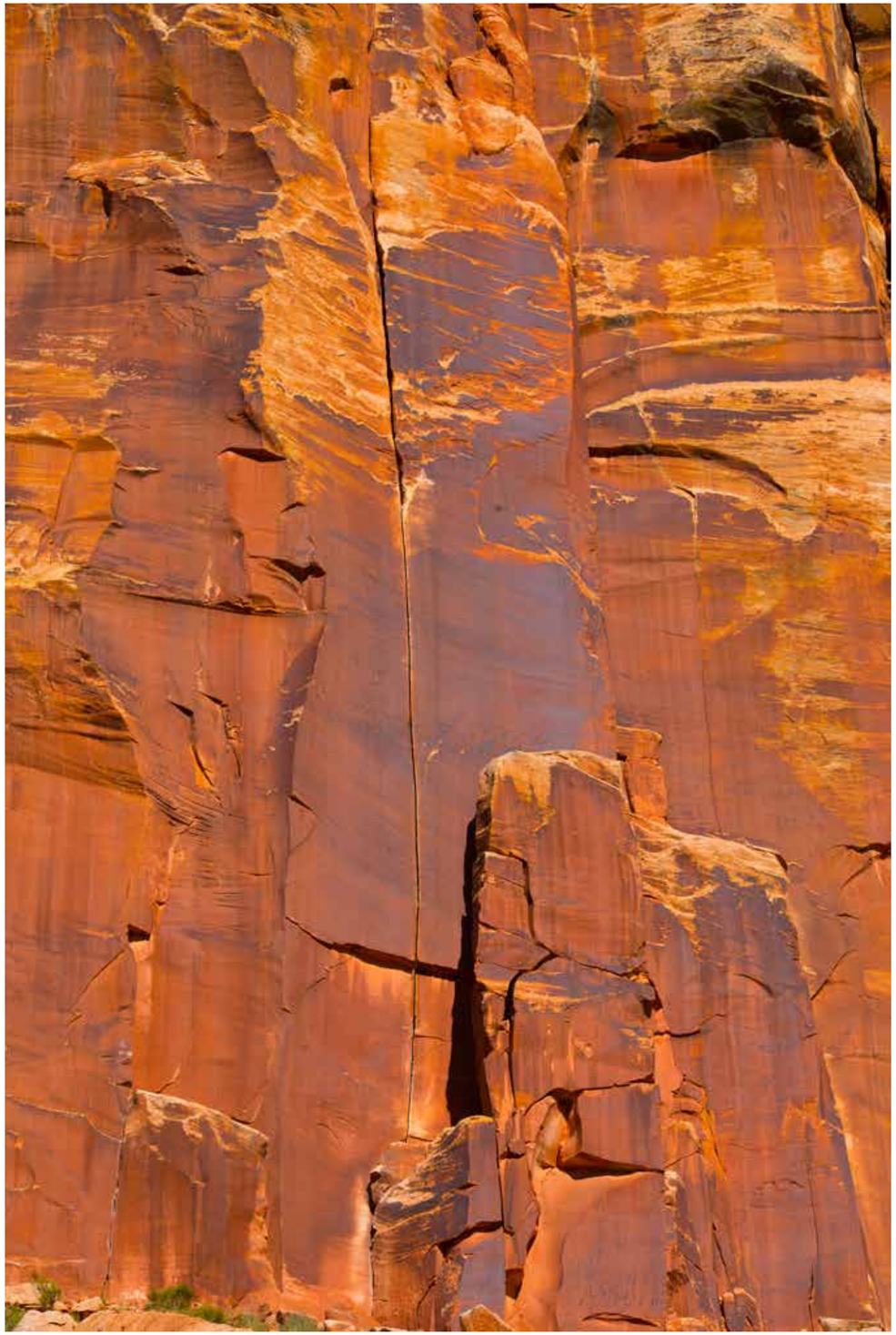
The issue with uranium mining—as with nearly all mining—has been with proper storage and disposal of tailings, as well as risks associated with abandoned mines. Together, they pose a nearly unimaginable risk to the province's environmental health. Several spills have already been documented (the Nuclear Regulatory Commission acknowledges ten accidental releases of tailings solutions into major watercourses in the region between 1959 and 1977 alone) and in 1979, tons of radioactive wastes and millions of gallons of contaminated fluid flowed into the Rio Puerco drainage at Church Rock, New Mexico.

Now move past economics, beyond science. Imagine these minerals coalescing, being shaped into new forms that walk and live and breathe and explain their very existence in terms of Earth. Several religions—Muslim, Jewish, Christian—believe that humans originated as earth and were breathed to life by a single great deity. In the Hebrew language, Adam is not only a proper noun, but one of the names for earth or ground. Hopi tradition holds that their people emerged from the Sipapu, a travertine dome that is considered the holy womb of the Earth, into this, the Fourth World. They also believe that their spirits go back through the Sipapu in death. No matter what your religious belief, it is not an act of faith to understand that most of the human body is made up of oxygen, carbon, hydrogen, nitrogen—and the rest a smattering of elements from the Periodic Table. We are made of the same things as soil, as earth.

And what is it with mountains? Why are so many of them given assignations of sacredness? The list is a diverse litany: Ararat, Olympus, Sinai, Fuji, Uluru. It is understandable that early man, impressed by that which he could not control and wanting to explain natural phenomena, assigned powers of gods as he watched one explode in volcanic glory. The Navajo hold four mountains sacred, three of them on the Colorado Plateau. Legend states that First Man and First Woman constructed the sacred mountain to the south, Tsoodzil (Mt. Taylor) using a great stone knife to hold the mountain in place and decorated its summit with turquoise, then added dark mist to produce the gentle female rain. The four sacred mountains of the Navajo, most born of fire, define Diné in a way that lines on a map cannot. Nor do Native peoples hold a monopoly on spiritual elements of the plateau. New Agers flock to Sedona to experience harmonic convergence and epiphanies of the vortexes, proving once again that new thought is really old thought. Depending upon the source, Sedona claims to greet between 3 and 4 million visitors a year, and Googling "Sedona vortex tours" will generate 500,000 hits.

First peoples of the plateau revere Earth and consider her their mother, and a mother provides for her children. Take, for instance, the traditional process of weaving a rug. Once the sheep was shorn, pulverized, toasted gypsum was sprinkled on the cut side of the wool to loosen dirt, absorb oil, and whiten the fleece. Limonite from Chinle or Mancos Shale, rock salt from Zuni Salt Lake or the Grand Canyon, or crude native alum are a few of the mordants used to alter the hue of plant dyes and make them more colorfast. A pamphlet originally published in 1940 by the Bureau of Indian Affairs shared these instructions to dye yarn: "Dip up about four gallons of very thick brick-colored rain water that collects in puddles on the mesa, add wet yarn, stir well, then boil for four hours, adding clear water as needed." The modern process might not be quite the same, but there is a merchant in Sedona dying tee-shirts with the oxide-tinged rock and selling them to tourists who are eager to wear the rock home.

San Francisco Peaks near Flagstaff, AZ, one of the peaks sacred to the Navajo and Hopi. Photo by Ted Grussing.



Supercrack on Indian Creek, Canyonlands National Park, UT. Photo by Tom Till.

Kathy Eckles Hooker came to the Navajo reservation in the mid-1970s to teach English. During her time there, she became fascinated by the traditional tribal ways of living. In her book *Time Among the Navajo: Traditional Lifeways on the Reservation,* she writes about observing day-to-day activities from goat herding to hogan building. Gradually, she came to realize that every project she observed on the reservation had a common thread: the land. Plants, water, wood, animals—and earth. Shelters and pottery and dyes and ovens. Throughout the plateau, the earth and rocks are canvas, architecture, decoration and sacred source.

We crave direct contact with the earth. Edward Abbey described the canyonlands area of Utah as "the most weird, wonderful, magical place on earth—there is nothing else like it anywhere." About half a million annual visitors agree. On the east side of Canyonlands National Park, in the Indian Creek area, there is a famous 300-foot schism in one of the sheer orange cliffs called Supercrack. Technically, it is a formation of Wingate Sandstone of the late Triassic period, stained by iron oxide and cracked by tectonic pressure and the forces of erosion. Discovered by climber Jim Dunn in 1971, its beauty and purity of line haunted him. Fellow climber Ed Webster described it as "…a vertical fissure of hand width, absolutely parallel-sided, splitting a smoother, absolutely vertical wall." In 1976, Webster, Earl Wiggins, and Bryan Becker decided to climb it. The climb was dangerous and there was some doubt about equipment holding in the soft stone on the cliff climb. Later, Webster said, proving that rock climbers really do walk a knife edge between crazy and really crazy, "Earl was thinking, this climb is worth dying on—it's so beautiful, it's so singular, so unique."

Can we believe Carl Sagan, the man who said that we are made of the stuff of stars? Of course. Billions and billions of sub-atomic particles can't be wrong. Neither can Crosby, Stills, Nash and Young. We seem to know that we are made of earth, that it is sacred life force and final resting place, and this plateau landscape tells us a story of wind and water and change that is more than inspiring. Climber Dennis Jackson, was talking about climbing but could just as well have been commenting on the desert landscape when he said, "It kind of possesses you." Our connection to land, to Earth, is undeniable. Faced with yet another geologic wonder of the plateau, we are first rendered speechless, and then compelled to assign words to things that already have their own voices. Spooky, stark, haunting, humbling, surreal, sinuous. We search for the right adjective, but understand intuitively that the true name is Mother.

Ancestral Pueblo pictograph panel of white human figures with their hands raised with a small superimposed red human figure, Grand Gulch Primitive Area, Utah. Photo by Fred Hirschmann.

KIMBEL WESTERSON has written about such disparate topics as weddings, art collecting, and phosphorous. In 2010, she earned her MFA in Creative Writing from the University of California, Riverside. Currently, she's at work on a book about genius loci and the lure of place. This is her first piece for *Sojourns.*

FOR FURTHER READING

Ancient Landscapes of the Colorado Plateau, by Ron Blakey and Wayne Ranney.

Where the Rain Children Sleep: A Sacred Geography of the Colorado Plateau, by Michael Engelhard.

The *Roadside Geology* series published by Geology Underfoot Books. See volumes on Colorado, Arizona, Utah, and New Mexico.

Dirt: The Ecstatic Skin of the Earth, by William Bryant Logan.

Also see *Dirt! The Movie,* directed by Bill Benenson, Gene Rosow, and Eleonore Dailly and based on Logan's book *Dirt;* and *Luxury Liner: The First Ascent of Supercrack,* directed by Chris Alstrin.