Rafting the Grand Canyon

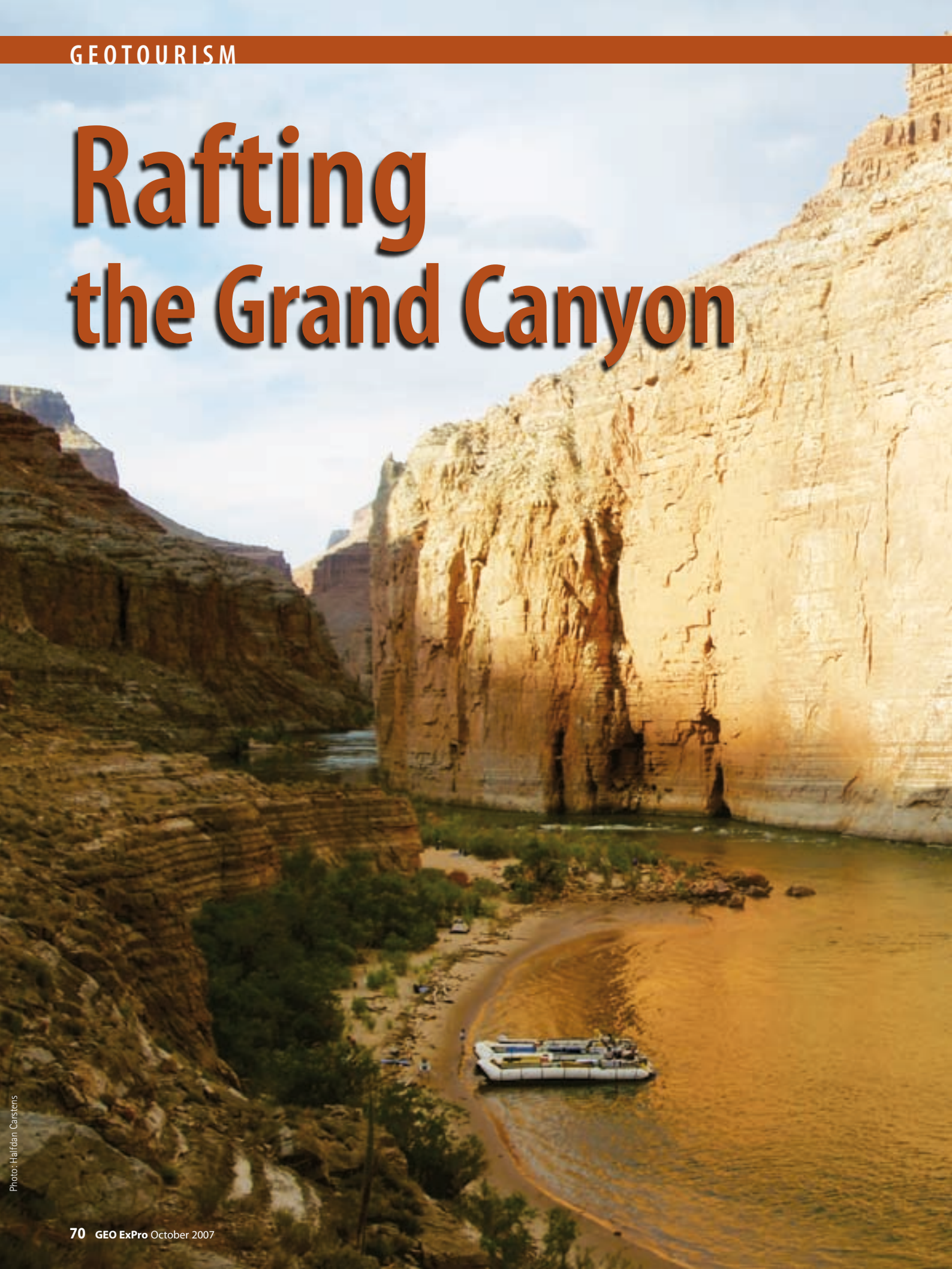

Photo: Halfdan Carstens

This is the ultimate experience for a keen geologist: Seven days of rafting through 300 million years of flat-lying sedimentary rocks of the Palaeozoic era and an intriguing record of Precambrian sedimentary and crystalline rocks. I doubt if there is a better way to get introduced to all kinds of rocks (sedimentary, magmatic and metamorphic) and geological processes. This is in particular true if you have a knowledgeable guide who let you experience the pure joy of being in this nature's wonder. If you ever get the chance, don't miss it!

Rafting the Grand Canyon should be on every geologists list of must do's – beginning at Lee's Ferry, you are level with the top layers of the canyon, and during the journey you will look upon magnificent columns of Palaeozoic sandstones, limestones, shales and lava flows, as well as Precambrian sedimentary and crystalline rocks. The Carboniferous Redwall Limestone, opposite the river in this photo, is seen as a thick cliff throughout the canyon. The carbonate rocks were deposited in a shallow to deep sea, tropical environment.

Cartography: Masaoki Adachi

Carved by the Colorado River, the Grand Canyon – running 440 km through northern Arizona – slices deep into the geologic province known as the Colorado Plateau, that is characterized by thick sequences of flat-lying sedimentary rocks. Within the Canyon, the Colorado River ranges in width from 25m to 250m, with an average width of 60 to 90m. The depth changes fast but may reach 30m in some places. For the most popular rafting trip that begins at Lee's Ferry, just below Glen Canyon Dam, and ends at South Cove at Lake Mead, the river drops more than 500 meters.

Photo: Halfdan Carstens

29 Mile Rapid: Be prepared to get soaked! While calm water dominates the Colorado River, in spite of more than 500m of dropping down, rapids are frequent and cool you down considerably. The rapids are the result of debris being dumped from side canyons into the river. In this rapid, the drop is about 2m.

Photo: Halfdan Carstens

Mile 157; Havasu falls: You can enjoy this scenery following a 5 km hot walk through a gorgeous canyon with turquoise, cold water running through. At the end you will meet the sparkling water of Havasu Falls over a cliff or travertine.

The Great Unconformity

Mile 120; Blacktail Canyon: The Great Unconformity, possibly the most interesting geological site in the Grand Canyon, is the gap in the record between tilted Precambrian age rocks and flat-lying Paleozoic rocks above (compare time-scale page 12).

In the Grand Canyon, the Great Unconformity represents a long span of time; up to 1200 million years, thus representing almost 25 % of the earth's history. This gap in the rock record also divides rocks without fossils (when life was mostly single-celled creatures) from those with fossils (when life began to evolve).

Below the unconformity lie the Precambrian metamorphic rocks that belong to the Grand Canyon Supergroup. This sequence of metamorphic and sedimentary rocks was tilted in the Neoproterozoic, some 800 million years ago.

Above the unconformity lies the Tapeats Sandstone of Cambrian age that was deposited in a coastal beach and a shallow marine environment.

The Great Unconformity was named by Major John Wesley Powell following the first journey through the canyon in 1869. Powell led an expedition of ten members in four boats and made it all the way to the Virgin River which is now below Lake Mead (compare map page 71). In March 1881, Powell assumed directorship of the U.S. Geological Survey.

This photo is from the Blacktail Canyon, 120 miles down the river from Lee's Ferry.

The Great Unconformity can be seen in several places along the canyon when rafting, but hikers can also have a splendid view of this spectacular gap in the geological record on their way down. In this place, seen from the Kaibab Trail and the Tonto Plateau on the south side of the canyon, the flat lying Tapeats Sandstone is resting on Precambrian massive and folded metamorphic rocks known as Vishnu Schists.

Unconformity

An *unconformity* is a large gap in the geological record that is formed when deposition of sediments ceases for a considerable time. It is thus a surface in the rock record representing a time from which no rocks are preserved.

Photo: Halfdan Carstens

Tapeats Sandstone

Vishnu Schist

Coloured by Rocks

Mile 34; Marble Canyon: The Grand Canyon geological formations stand out as dark, chaotic, crystalline Precambrian rocks in the deep bottom, with flat-lying sedimentary Palaeozoic rocks above. The sedimentary rocks reach all the way up to the rim along a colourful slope mixed with steep cliffs.

In the Grand Canyon, the youngest sedimentary rocks preserved are those from the Palaeozoic era, which lasted some 300 million years. Mesozoic strata, now found farther east and north on the Colorado Plateau, once covered this sedimentary basin but they have been eroded during uplift of the plateau in the Cainozoic (GEO ExPro vol. 4, No 1, 2007, pp. 50-54).

This Redwall Limestone dominates the walls of the Marble Canyon. The formation was formed in the Carboniferous (Mississippian) and is composed of marine limestones and dolomites. This is probably the most prominent rock layer in the Canyon and can be studied along the entire river by floaters. It usually forms a steep cliff up to 150-200m, and has thus become a natural barrier between the upper and lower regions of the Canyon.

The deep reddish color of this layer is caused by iron oxides leaching out of the layers above it and staining its outward face. Behind the reddish face the rock is a dark brownish color. Numerous marine fossils can be found in the Redwall Limestone including brachiopods, clams, snails, corals, fish and trilobites.

Mile 33 Redwall Cavern
The Redwall Cavern is carved by the river and was first spotted by John Wesley Powell. It is vast, and he estimated it would hold more than 50,000 men. The cave is only accessible from the river. The sandy floor of the cavern makes it ideal for tossing a frisbee around.

Photo: Halfdan Carstens

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Remnants of Volcanism

Mile 188; Whitmore Wash: The volcanic eruptions some 250,000 years ago, in the Middle of the most recent ice age, are by several geoscientists held as the most significant event in the recent history of the Grand Canyon. Here, at Whitmore Wash, more than half-way through the canyon, we get a splendid view of lava dam formation and destruction

Volcanic dikes that cut through the canyon walls, and which are the visible remnants of the paths along which lava reached the surface, are easy to spot as we float leisurely down the calm passages of the river in between the numerous rapids. Cinder cones, more evidence of the volcanic activity in Quaternary times, can also be seen occasionally on the rims of the canyon.

The most interesting and eye-catching features are the slabs of black basalt (the most common type of lava) stacked against the canyon walls. These are what are left of a series of ancient lava dams that once blocked the Colorado River and caused huge lakes to form in the canyon.

Arriving downriver from Whitmore Rapid, a mere 1m drop, late in the afternoon, and camping for the night along the shore of Whitmore Wash, we also get the luxury of seeing this dramatic landscape in the twilight hours.

Photo: Halfdan Carstens

Mile 178: Vulcan's Anvil, situated in the middle of the river, rises more than 20 m above the water just before entering Lava Falls. The volcanic remnant stands out as a massive rock pipe that floaters need to be careful not to hit, also because Native Americans prefer that sacred sites remain untouched. From this point, ancient lava flows extend downriver for another 120km.

Photo: Halfdan Carstens

Having fun with rocks and water

Mile 61: The Little Colorado River, carved into the Palaeozoic sedimentary rocks of the Colorado Plateau on the south-eastern side of the canyon, is coloured turquoise by a high concentration of dissolved mineral material, and with the reddish rocks towering above; we get an inviting scenery for today's entertaining swim in wild water.

The river originates in the Painted Desert in the Coconino County in Northern Arizona, and runs 51 miles before it ends up in the Colorado River. The river runs through the Navajo reservation, and is considered sacred by the Navajo and Hopi Indians.

The warm, turquoise water of the Little Colorado stands in contrast with the cold blue water of the Colorado. The higher temperature in the Little Colorado is due to water passing over heated rocks on its short way down from the plateau, in contrast to the main river which originates as snow in the high Rockies.

Where the Little Colorado runs into the Colorado river, we stop and walk about ½ mile up the river where part of the fun is to swim down the river and steer past large boulders that together reveal the powerful forces associated with floods.

"While tightening my life vest, I'm getting the last advice from one of our river guides; keep your feet in front of you as you go through the rapids and lift your bum! Otherwise you might hit a rock… A little bit scared to bruise my behind, I lunge into the water and dip under for a second. As my head pops up over the surface again, I position myself as I approach the first part of the rapid. Pointing my camera forward, I am hoping I am getting a decent shot, however it is difficult steadying a camera while you are fighting to keep your rear end up high and your head above the water – have a go at it yourself – it is a tremendous amount of fun," says Ingvild.

The Art of Studying Geology

It is about a 450 kilometer trip through the canyon. If driving a car on a winding road along the banks, it would take some 5-6 hours to get from Lee's Ferry to Lake Mead. But you would not be in a position to experience the real beauty and the many wonders of the Canyon.

The best way to do this is certainly to join a rafting trip or take one of your own. As an alternative, it is fully possible to hike the many trails in the Canyon, some of them going all the way down to the bottom.

With a raft it takes a week, given that it's powered by a small outboard motor and that you are in no hurry. That leaves you time to hike the side-valleys, go for a swim in the tributaries, play in the waterfalls, enjoy long lunches on the riverbanks, have lots of fun in the rapids, and – not the least – study the rocks and the geological formations that were you're the real reason for going in the first place.

The river itself is not very impressive in terms of size. Actually, it is quite small, and to many it is an enigma how it can have carved this enormous canyon. The answer lies in the time it has excelled its forces.

This large amount of time, lasting at least all the way back to the Miocene, and even longer, explains why the canyon is there. As for many other geological phenomena and processes, time is the answer.

Photo: Halfdan Carstens

Wayne Ranney
For one week, seven days and seven nights, Wayne Ranney, was our guide when experiencing the Grand Canyon as Canyoneers on a raft drifting leisurely down. He taught us local culture, river history, and – above all – geology. His intimate knowledge of the Canyon, gained through numerous trips both on the river and on the trails, and his broad geological insight, combined with excellent skills as an educator, made him the perfect leader of a pack of curious geologists. Thanks also due to the Geological Society of America that put together this "once in a lifetime" field trip.