Notes on black granite

Lee Gass

I carved two sculptures from a block of granite quarried in the Sierra Nevada mountains of California, not far south of Yosemite Valley. Actually, I carved one sculpture, then dropped it on the floor, producing the two you see here, plus two fragments I haven't yet used. This document is not about the sculptures, however, but about the stone, which I found an absolute thrill to carve in every way. It is strong, it responds well to both percussion and abrasion, and it polishes to a fine surface that glows with the purple-black hue of the stone, reflects the environment coherently, and catches highlights. It is a perfect carving stone in many ways, which made me interested in it as a geological phenomenon. Here I share what I learned with you.

Holding Firm at 65 is the top-most piece of the sculpture that I dropped,

and *Torso in Motion* is the bottom-most. I still have the two pieces from the middle and intend to use them.

Unlike the stark white surfaces of El Capitan, Bridal Veil, Half Dome, and other famous features of Yosemite valley, this stone is dark, nearly black when it is polished, and a very different thing to carve. Dark granite behaves differently in other ways as well, most dramatically in its response to changes in temperature. Yosemite granite is white because that region of the Sierra Nevada batholith is relatively rich in quartz, whereas in the Raymond region to the south, where this granite was quarried, quartz crystals are few and far between and it is dark. Because of the quartz, Yosemite white granite reflects and refracts light to a much greater extent than the dark feldspars and ferromagnesian minerals that predominate where *Torso in Motion* and *Holding Firm at 65* were quarried. Its responsiveness to electromagnetic energy lends interesting electrical properties to quartz, and it expands and contracts more as it heats and cools than the crystals that predominate in darker portions of the batholith. White granite's coefficient of thermal expansion is relatively higher than that of dark, and this carries great consequences for both types of stone.

White granites, such as the grano-diorite of the Trinity Alps in northwestern California, where I did my hummingbird research at Grizzly Lake, tend to be flaky, both at the fine scale on which coarse sand crumbles from the surfaces of rocks and at the scale on which hand-sized flakes, or much larger, exfoliate. This happens seasonally, as the average temperature of the rocks goes from however cold in winter to however hot on summer afternoons. And in the mountains, daily swings of temperature can be extreme.

Imagine the forces that develop as one face of a cold white granite ridgetop soaks up sunlight and expands while its interior is still chilly and contracted. This continues hour after hour, day after day, for millennia, along with other things like abrasion by blowing snow, ice and sand, water expanding behind flakes as it freezes, and the grinding of glaciers. John Muir imagined these things in the Yosemite region at the end of the 19th Century and described them eloquently.

Thermal expansion also allowed Roy Faulkner and others to carve the Confederate Generals and their horses into Granite Mountain, a few miles east of Atlanta, with a torch. The torch burned kerosene and pure oxygen in a combustion chamber, and

the gases it exhausted from its snout were as hot as 5000° F and moving several thousand feet a second, thrusting the torch backward like a rocket. The torch focused heat on a small spot on the side of the mountain, and surrounded it with a curtain of cold water. Under these conditions, the stone in the centre of the circle expands rapidly while its circumference cools and shrinks, and burning hot flakes pop off in all directions. With this kind of tool, which is both dangerous and loud, and with enough quartz in the granite and enough oxygen and fuel for the torch, one sculptor can "move" several tons of stone a day.

The torch won't touch black granite, though, because it doesn't have enough quartz. But just as its ability to expand thermally makes white granite valuable for carving with a torch, black granite's lack of quartz makes it valuable for other things because of its inability. A good example is in the manufacturing of computer chips, where black granite is used not in the computers themselves, but in the machines that make the chips. Each machine is built on a large, heavy, stable block of black granite, milled to a high standard of flatness and studded with high-tech optical and mechanical equipment.

One day in 1991, my cousin Jeff Hawkins called from Portland to offer me a large block of black granite. He worked for a company, Etec (previously Atec and now Applied Materials), where they made a machine like that. It was the best of its kind in the world, and it sold for a figure that made my head swim (just a few of them a year). Jeff was the senior mechanical engineer on the project, a member of the team that designed, prototyped, tested and improved that machine and both thermal expansion and vibration were his enemies.

Rigidity and mass are what damp vibration, and white granite has plenty of both of those. But because it is high in quartz, white granite would respond too much to temperature, even though the machine's own, private, constant-temperature clean-room, fed by electrical cables and pipes bearing heating and cooling fluids, keeps it within a gnat's eyelash of constant temperature and therefore keeps the distances between components of the machine as precisely constant as it is humanly possible to achieve. Only black granite will do, and the best black granite on the market, at least for this use, comes from Raymond. Not only is its coefficient of thermal expansion unusually low, but its density is unusually high at 186 pounds per cubic foot, serving both needs at once.

As I said, vibration and thermal expansion were Jeff's enemies. But if I understand the physics of it, a trick that the team dreamed up, involving multiple exposures of a photoresistive coating by a power laser, enabled the machine to draw lines on a piece of glass finer than the laws of optics would allow. With white granite under the laser and the prisms, lenses, and mechanical stages, the machine would have had to obey the law. The supreme mass and dimensional stability of this particular granite were essential, because they allowed it to do the impossible.

The reason Jeff called me was that someone at Etec had asked what they were going to do with a block of black granite that was useless to them because of holes drilled in the wrong places for mounting equipment. Jeff volunteered himself as the garbage man and me as the dump, and one weekend Cousin Jeff and Cousin Jim came to visit, hauling the block behind them on a trailer. It was beautiful, perfectly flat on every face,

and very big and heavy. Measuring roughly 40 ¼ x 36 x 12 $^{3}/_{8}$ inches on a side, it weighed nearly 1900 pounds - - almost a ton.

It stood outside my carport studio until shortly before I moved house, serving as an oversized coffee cup holder, a conversation piece, and inspiration. Then I split it into four carvable pieces, and roughed out my third *Dream Person* sculpture before moving. Because I had no place to carve a big piece of granite there, it stood in the front yard for 14 years before we built the studio on Quadra Island, where it became *Torso in Motion* and *Holding Firm at 65***.** I still have three of the blocks, one of which serves as a plinth to hold one of my first sculptures, a human torso in almond wood dating from 1961.