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John McPhee's *Basin and Range*, the first of his geology books usually read in a collection as the (sized rather like a large rock itself) *Annals of the Former World* is a funny choice for a *Passages* classic, at first glance. Maybe at second glance too, come to think of it.

*Basin and Range* is a travelogue, haphazard intro textbook on plate tectonics, and a meditation on the Earth, its age, and the rocks that give us some clue to almost utterly alien worlds that once occupied the space we now inhabit. Lava flows, trilobites, ancient seas, and primordial continents; the great extinctions that bookend geological periods of time, what does this all have to do with software engineering?

The answer is that geology is the best metaphor I know for the actual practice of software archaeology, attempting to understand truly large and complex software systems. Like the Earth itself, a sufficiently large software system is beyond human comprehension; the would-be knower must guess and extrapolate and fantasize.

Late in *Basin and Range*, McPhee writes:

“In the nineteen-forties, a professor at Delft had written a book called *The Pulse of the Earth*, in which he asserted with mild cynicism that where gaps exist among the facts of geology the space between is often filled with things ‘geopoetical,’ and now Hess, with good-humored candor, adopted the term and announced in his first paragraph that while he meant ‘not to travel any further into the realm of fantasy than is absolutely necessary,’ he nonetheless looked upon what he was about to present as ‘an essay in geopoetry.’ He could not be sure which of his suppositions might be empty conjecture and which might in retrospect be regarded as precocious insights.”

Alas, we have no prefix so useful as “geo-” but understanding of a code base such as modern mac OS involves much poetry of some sort, and not the Longfellow/Alexander Pope kind, something modernist and obscure.

Rocks are in layers, though the layers are not, at least in the American West and Southwest, where *Basin and Range* spends most of its time, nicely ordered. Mac OS is in layers. At the bottom, underneath primal rock, the base of the Grand Canyon, a digital Vishnu schist, is the (not actually present as code) UNIX written by Ken Thompson. The earliest strata actually visible is BSD, the Berkeley Standard Distribution, a completely different UNIX that is still UNIX. Mashed in here is the Mach kernel, which post-dates BSD, but is at the bottom of mac OS. One can see the NeXTSTEP orogenesis, a specific geological activity phase, in which new code was erected, and other annals of the former world.

Now, our task is often considerably more pleasant than that of the geologist. For one thing, the amount of time involved is unfathomably less daunting; for another, the underlying processes of

computer hardware and operating systems are far better understood than those taking place deep in the mantle of the earth. We do not have to hypothesize convection cells, before we have much evidence that they are there, we can just look it up. Additionally, the Earth and its depths of time and miles-below-the-surface were not, one suspects, designed with the goal of allowing mere mortals to understand them. At least some software systems show evidence that someone probably intended the thing to make sense. Finally, geological layers are always erasing each other, covering up the evidence, while, at least these days, we often have the extraordinary detailed history offered by a version control system. Imagine what geologists could do if the earth had a github repository, even with very bad commit messages!

The analogy can only be taken so far. However, it does offer a perspective that Passages can completely endorse: we should always be aware of the great difficulty, and even impossibility, of truly understanding complex software systems. It is safe to say that no one actually “understands” all of a large modern operating system, or even a large fragment of it. On the other hand, we should be grateful for the ease of attaining a partial understanding, or answering a specific question, compared to other practitioners operating in a complex, historical, setting, examining an object of vast complexity whose roots extend into a distant past.

I should say more, but I must go and take a pickaxe to my code. Field geologists often carry a little vial of weak acid; what should we carry?