

## Discussion

# Our Sliver of Time

*In which we reflect on three milestones in the maturing of our moist blue planet—the dawn of life, the growth of oxygen, and the first Earthlet spores—stunned by the privilege of being alive during our brief sliver of time.*

Less than four decades ago, life flew off Earth to visit another celestial body. It was an extraordinary milestone in the maturing of our planet. Indeed, when ranked with other events during the almost five billion years since our planet condensed-out from cosmic debris, I think only two rank its equal.

The first occurred nearly four billion years ago when life itself began. Early life required neither sunlight nor oxygen and came to be called anaerobic. Oxygen was a poison to this early life that had grown up in a world without an oxidizing atmosphere.

The second happened about two billion years later when aerobic life, deploying blue-green bacteria as mop-up infantry, achieved victory over anaerobic life. In the winning, oxygen, the victor's excrement, came to dominate atmospheric chemistry, pushing it out of equilibrium from the rest of Earth—keeping it out from then until now—and confining anaerobic life to small ghettos, like our intestines.<sup>1</sup> Aerobic life had waged the first chemical warfare. Like so many disruptive events, this was another two-edged sword. By changing the atmosphere to an oxidizing environment, aerobic life opened the door for still newer kinds of life. These new species took oxygen from the atmosphere, used it to mine exergy from material originally produced by photosynthetic life and, thereby, won for themselves the prize of mobility. And so, in time, aerobic life came to allow us.

After this second milestone, it seems to me there isn't a planetary event that can rank with humans walking about the moon—not because it was “One small step for (a) man, one giant leap for mankind,” which I think is to trivialize—but rather because it was the beginning of the next epoch for our planet. It marks *life's* first baby-steps to colonize the universe.<sup>2</sup> A few Earthlet spores had taken flight.

At the time, the moon landings engaged the imagination of all people. Today that engagement is little more than a warm ember. Still, flying to the moon bequeathed wonderful legacies—many still too close to fully appreciate. Of these many legacies, two are especially relevant to our odyssey towards a cleaner, richer hydrogen age.

*The view from space.* The photographs of Earthrise appearing over a lunar landscape bequeathed an altered, visceral perspective of our home. Although unable to prevent tragedies born of greed, religions and power lust, the view from space *did* change how we think about our planet. Seen from afar, Earth became something we must protect. Soon after, space programs gave something more: they quantified many of the risks Earth faced. If it were not for satellites we would have learned much later and with much less precision about ozone holes and other intrusions upon the global commons.

In the fullness of time, history *may* observe that the space programs of the 20th Century inculcated us with a less-insular view of our role on Earth—and it *may* be that this more-generous view grew into a near-universal *Zeitgeist*, which in the early 21st Century, ultimately “saved” planet Earth from itself.<sup>3</sup>

<sup>1</sup> While only a little more than 20% of the atmosphere, oxygen dominates atmospheric chemistry.

<sup>2</sup> At least, Earth-based life. None of us can be sure extra-terrestrial life hasn't gone before.

<sup>3</sup> Nowadays, “Save Planet Earth” seems a particularly anthropocentric view of what needs saving. What we *mean* is “save *today's* environment so people can live comfortably.” Yet, as the GAIA theory has so well explained, terrestrial life is robust. If people mess things up, push today's metastable equilibrium off kilter and into new extremes—extremes unpalatable to us—they'll be delightful to new, emerging life forms. Life on Earth will go on flourishing—but perhaps without us. Still, I don't feel guilty about wanting to keep things pleasant for us and for our cohabiting species. A fundamental rule keeps Earth alive: Every species must fight to survive and a core survival strategy is to make conditions attractive for itself. I don't, and we shouldn't, apologize for living by that rule.

*The energy currencies of space.* The staple currencies of space technologies are electricity and the protonic pair, hydrogen-oxygen. From the viewpoint of technology development, we were lucky the missions that first deployed these technologies were driven by a grand objective, not immediate economic payback. Subsidized by national pride, we learned much about the coming hydrogen age. We learned about fuelcells, about hydrogen production, handling, safety, liquefaction, about hydrogen-compatible materials. . . .

Today, these are precisely the technologies that must colonize civilization's terrestrial energy systems, *if* we are to defend our planet against the dangers those same space programs identified and then quantified.

But now, that first excitement of sending people to the moon has melted. We have witnessed the fracturing of planned economies in Eastern Europe and Northern Asia. As a result, the prospect of global conflagration might have diminished, but only to be replaced by vicious regional conflicts, scattered in pockets among the continents. More recently, growing religious fundamentalism has been fertilizing the prospect of nightmarish conflicts.<sup>4</sup>

With these on-Earth obsessions, it's no surprise that, for venturing off-Earth we are—as the French might say—in *la pause créatrice*. After the first moon emissaries showed space travel possible, we're now in times like those when Europeans were waiting to colonize the Americas after Columbus and others had shown they were there. Still, as always, within the distemper of our times, good things are happening.

Today, imaginative and courageous investors and innovators are improving efficiencies and lowering costs of these originally-deployed-in-space technologies. In so doing, they are preparing them to colonize energy system on Earth over the next 50–100 years. Not all the bits and pieces are ready, but they will come. And when they do, a wave of new energy systems will begin to roll, pushing back environmental stress, improving public health, seeding economic revitalization, enriching the joys of being alive.

Let's look a bit further into the future. A what-goes-around-comes-around codicil to terrestrial application will be that these technologies are thereby readied for the next grand epoch of space exploration. It would be impossible to colonize space today, using only today's expensive vehicles and hydrogen–electricity systems. So the sequenced steps along the path to the future seem evident. We must *first* develop hydrogen technologies for deployment at home on Earth. *Then*, having lowered costs and raised efficiencies, we will have technological readiness for extraterrestrial colonization.

Curiously, this sequenced perspective is entirely coherent with the systemic evolution outlined in earlier parts of this book. We have merely changed the timeframe from decades to centuries, and thereby have placed our evolving energy system in the context of planetary destiny. That is why I've come to see our brief sliver-of-time as subdivided into three much-shorter phases.

1. The second half of the 20th Century: a time glorified by a cost-be-damned demonstration that we *can* send emissaries from Earth's biosphere to another celestial body. *The energy currencies for these first missions were electricity and the hydrogen-oxygen pair.*
2. The first half of the 21st Century: a time when performance improvements and cost reductions will allow these technologies to colonize down-to-Earth applications. *They will power a wave of wealth-creating industries that bring improved quality of life and environmental security here on Earth.*
3. The second half of the 21st Century and the early 22nd Century: a time when people again turn their eyes to the stars. *Using technologies readied for extraterrestrial voyaging by terrestrial deployment, Earthlet spores will set off to fulfill our planet's destiny. Earth will be going to seed.*

Each of these steps requires the preceding step. It is sad that those nations who so brilliantly launched the moon flights are not exploiting their legacy. Unfortunately, we seem to prefer using the legacy as a platform for bluff, bluster and building weapons for war. How much better, had we built upon the gifts spawned by the space race to create wealth for ourselves, to clean up the planet for everyone—to achieve international leadership appropriate for the 21st Century.

Five billion years ago our corner of the universe was taking shape from stardust—the debris of supernova. Our local patch of star detritus was spinning, condensing, becoming our solar system. Most debris was gathering at the center of things, shaping up to be the sun. However, a bit out from the main event, Earth was also condensing and twirling much faster than today—a frenzied planetary ballerina. All the while gravity was collapsing the hydrogen-dominated

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<sup>4</sup> Among the great religions, many were born in the minds of men wandering alone through mid-Eastern deserts.

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