cal means by which the first life could have arisen. Almost all steps in the process require energy.

The energy source for the formation of the first plant life could have been lightning from the numerous storms that racked the planet. It also could have been nuclear radiation from the radioactive material in the Earth's crust. Hot springs that utilize heat from volcanic sources deep within the Earth are favorite sites for investigation.

One of the most exciting discoveries of recent times is the curious life forms that exist around deep-sea thermal vents. These warm-water vents lie more than a mile beneath the surface where there is no sunlight for photosynthesis. The giant clams, white crabs, and large tube worms (up to 5 feet in length) that live near these vents appear to exist on bacteria. The bacteria themselves are thought to utilize hydrogen sulfide, which flows up through the vents, combined with oxygen and carbon dioxide in the sea water to obtain energy.

By far the most important single energy source for the initial steps toward life was ultraviolet radiation from the Sun (see table 7.1). Because there was no ozone shield present in primordial times, the Sun's ultraviolet rays would have struck the Earth with far greater intensity than at present (see figure 7.2). While useful in providing energy to chemically synthesize initial organic compounds in the atmosphere, it must be remembered that this same high energy ultraviolet radiation is destructive not only to living cells, but also to their more advanced (non-living) molecular building blocks. Therefore, life must have begun in a place shielded from the Sun's lethal ultraviolet rays. Such a place could have been beneath moist soil, in tidal mud flats, or under a layer of water.

Primordial energy sources in terms of the percentage of average total energy they would have supplied at each point on the Earth's surface.^1

ultraviolet radiation	99.8%
electrical discharges	.12%
natural radioactivity	.08%
meteorites	.03%
high-energy particles	.006%
volcanoes	.004%

Table 7.1

The fossil record provides evidence that blue-green algae existed on platforms of boulders and rocks submerged in shallow water. These platforms would have to have been deep enough to be shielded from ultraviolet radiation, but shallow enough to receive the light wavelengths essential to photosynthesis. The fact that oxygen levels decrease with increasing water depth together with blue-green algae's known intolerance of oxygen tends to give credence to this hypothesis.

Further, the tolerance of blue-green algae both to limited ultraviolet radiation and to lack of oxygen suggest that it, or perhaps earlier life forms, could have arisen in the primordial hostile environment. Nevertheless, determining the energy source and the shielded environment,

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