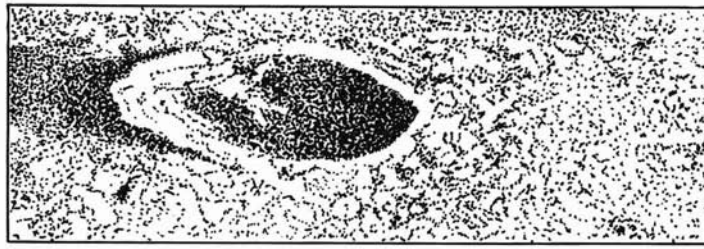

IV. Tektites and Meteorites

Tektites are high-silica glassy objects, ranging in size from microscopic to weighing a pound or more. Superficially, they can resemble corroded pebbles of obsidian (Photo 42). From the beginning of scientific work with tektites, they were found scattered about the surface of the Earth in many localities, with no apparent relationship to local geology. This fact led F. E. Suess in 1900 to conclude that tektites were a glassy variety of meteorite. Many other ideas followed, and some investigators changed their minds many times. Vexed by the tektite origin problem, well-known geochemist Henry Faul stated, "To anyone who has worked with them, tektites are probably the most frustrating stones ever found on earth."[12] Part of the frustration resulted from lack of data on the

[12]For a technical summary of the tektite problem see E. A. King, "The Origin of Tektites: A Brief Review," *American Scientist*, vol. 65, no. 2 (1977), 212–218; or S. R. Taylor, "Tektites: A Post-Apollo View," *Earth Science Review*, vol. 9 (1973), 101–123.

field occurrences of some of the tektites. A portion of my dissertation work sought to determine the field relationships of the tektites found on the Georgia Coastal Plain. Barnes, who visited some of the tektite localities in Georgia, had little success either in finding new specimens or narrowing down the stratigraphy of their occurrence. There was an apparent "age paradox" with the Georgia tektites. Analyses gave radiometric ages of about 34 million years, but tektites were thought to exist on a Miocene formation, which was considerably younger.

I contacted the Georgia State Geological Survey, and they agreed to furnish a truck for my work. A local gentleman, Will Sellers, had previously found a tektite near his home at Jay Bird Springs. I had to start somewhere, so I decided to visit him. He lived alone in an old weathered house on a small country road. He had little to do besides sit on his front porch. Needing some local contact to get me on private land and keep me out of trouble, I asked him if he would agree to act as my "field assistant" for the next month. He agreed to help but said I would have to pay him. When I asked what he thought a fair wage would be, he surprised me by saying, "Two

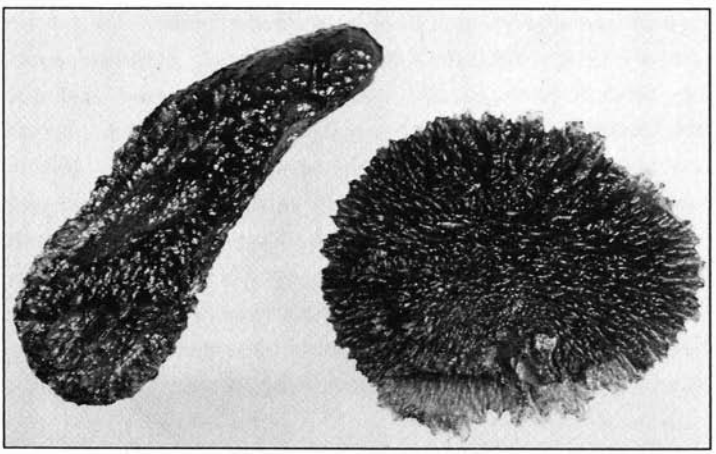

Photo 42. Transparent green tektites from Bohemia, Czechoslovakia. Length of drop-shaped piece is approximately five centimeters. (Photograph by the author)

dollars a day." Sellers proved to be invaluable because everyone in the county knew and liked him. During the course of the field work, we found two new tektite specimens, purchased two more, mapped the entire surficial geology of Dodge County, and managed to avoid a dozen portable propane-powered white-lightning stills. Although I obtained a lot of new information about the Georgia tektites and their occurrence, nothing I turned up seemed to bear on the important questions—how and where did the tektites originate?

By the time I arrived at NASA in late summer 1963, only three possible origins of tektites were seriously being considered: 1) origin from lunar volcanoes, 2) origin as melted ejecta from meteoroid impacts on the Moon, and 3) origin as melted ejecta from large meteoroid impacts on the Earth. The lunar volcanic origin theory fell by the wayside because it did not have a strong champion and it was generally believed that lunar volcanoes were not sufficiently energetic to accelerate volcanic melt to lunar escape velocity.[13] Rejecting the lunar volcano idea left the two impact origin ideas, which were essentially the same except for the location of impact. O'Keefe had supported the idea of a lunar origin for tektites in a series of papers beginning as early as 1960, primarily on the basis of theoretical arguments. The supporters of a terrestrial origin for tektites were frustrated because their only strong argument lay in the chemical similarity of tektites to Earth materials—and the chemical composition of lunar rocks was unknown. Four occurrences of tektites were known at that time: two localities in Czechoslovakia and one each in the Ivory Coast, North America, and Australia and southeast Asia. The youngest group of tektites in Australia and southeast Asia contained specimens that clearly showed two melting periods—the original melting to make the bulk of the glass and a second period of partial melting on one side apparently caused by atmospheric ablation. A series of glass abla-

[13]It is interesting to note that this idea was resurrected years later by O'Keefe when it became apparent that tektites did not come from the lunar surface. See J. O'Keefe, *Tektites and Their Origin* (New York: Elsevier Scientific Publishing Co., 1976).

tion experiments conducted at the NASA Ames Research Center by Dean Chapman and Howard Larson[14] reproduced the shapes of the ablated tektites almost exactly. Chapman and Larson argued that the tektites had to originate from the Moon; otherwise, the detailed shape of the ablated layer and the geometry of the ring-waves formed on the ablation-melted surface would be different. The experiments provided powerful support for the lunar hypothesis, which was forcefully presented by Chapman. The arguments raged. Barnes and Urey were firmly committed to a terrestrial origin. Adding to the excitement was the anticipation everyone felt in knowing a final answer was only a few years away.

A junior colleague of O'Keefe's at the Goddard Spaceflight Center found the very high pressure silica mineral coesite in tektites.[15] This discovery further supported the impact origin because coesite is known to form on the Earth's surface only in impact craters. Of course, it might also form in cratering events on the Moon's surface.

It was gradually realized that the Czechoslovakian tektites came from Ries Crater, a large impact crater in southern Germany. Radiometric age dating showed that the Ries Crater and the Czechoslovakian tektites were both 15 million years old. Likewise, the Ivory Coast tektites were found near the Bosumtwi Crater in Ghana, and both the crater and the tektites were dated at 1.3 million years. This connection furnished strong evidence to most impartial observers that the impacts that formed craters in the Earth also formed tektites.

My personal research with tektites continued from time to time, and I contributed to a better understanding of the physical properties, inclusions, and field occurrences. However, I was unsuccessful

[14]D. R. Chapman and H. K. Larson, "The Lunar Origin of Tektites," NASA Technical Note D-1556 (Feb 1963), 66 pp. Also, D. R. Chapman and H. K. Larson, "On the Lunar Origin of Tektites," *Journal of Geophysical Research*, vol. 68 (1963), 4305–4358.

[15]L. W. Walter, "Coesite Discovered in Tektites," *Science*, vol. 147 (1965), 1029–1032.

in obtaining data that uniquely pointed to either a terrestrial or a lunar origin.

Charlie Schnetzler finished his Ph.D. work at MIT and was hired at the NASA Goddard Space Flight Center, where Walter and O'Keefe were his colleagues. Schnetzler continued to work with his graduate school professors, Drs. Bill Pinson and Pat Hurley, who were strong supporters of a lunar origin for tektites. In 1966 they investigated the strontium/rubidium age and isotope systematics of the Ivory Coast tektites along with rock materials from the nearby Bosumtwi Crater in Ghana. They found that not only did the tektites and crater rocks lie on the same isochron and their isotope systematics were virtually identical, but that the isotopic ratios were very unusual. They concluded that "the evidence available at present suggests that the Ivory Coast tektites are most probably the fusion products of meteoritic impact at the Bosumtwi crater site"—a dramatic change of opinion for this research group. The evidence and arguments that they presented were quite convincing.[16] Schnetzler's work was proof of a terrestrial origin. His ideas were accepted by almost everyone except, curiously, his own colleague, O'Keefe, who continued to cling to the lunar origin idea.

At the time, I was working with a Czech researcher to determine the cause of color variations in an unusual Czechoslovakian tektite we had borrowed from the Prague Museum. We believed it was appropriate for us to present our results at the International Geological Congress to be held in Prague in August 1968. My wife and I arrived in Prague a week early, met my Czech colleague, and travelled to southern Bohemia to investigate the field occurrences of some of the Czechoslovakian tektites. We stayed in small towns and quaint hotels while spending several beautiful days in the field. We visited several tektite localities in gravel pits and farm fields and collected a number of fine specimens. We returned to Prague one day before the congress and behaved like tourists. The people of

[16]C. C. Schnetzler, W. H. Pinson, and P. M. Hurley, "Rubidium-Strontium Age of the Bosumtwi Crater Area, Ghana, Compared with the Age of the Ivory Coast Tektites," *Science*, vol. 151 (1966), 817–819.

Prague were excited about their recent political successes. The Russian yoke was lighter than it had been only months before. The names "Dubcek" and "Svoboda" were on everyone's lips. The mood was almost jubilant.

The opening of the congress was uneventful. Our paper was scheduled for later in the week. On the second day, we heard many low flying jets in the evening and early morning hours, but we slept anyway. On the morning of August 21, we knew something was wrong. We dressed in a hurry and went to the hotel dining room. The staff were in tears. Looking through the large dining room windows, we saw a man excitedly handing out newspapers to the people on the street outside. Then, at the end of the street, appeared the lead tank of a Russian armored column, coming toward us at a deliberate pace. Young soldiers with submachine guns were lying on their backs on both sides of the tank and watching the rooftops and windows for possible gasoline bombs. We moved away from the windows.

The telephones didn't work for two days, and we could not contact the American Embassy. When I finally got an operating line, a very tired voice told me that an American diplomatic representative would lead a convoy of Americans out of Czechoslovakia the next morning. The convoy would form at a little village called Rudna. We didn't have a car, but I remembered that my old professor, Bullard, and his wife were staying in our hotel. I found Bullard, told him of the embassy plan, and asked if he had a car. He did! It was a little VW beetle, but the four of us and our luggage, which I was prepared to abandon, fit into it nicely. Our biggest strategic problem was that we were on the wrong side of the Vltava River. We had to cross a bridge, but all of the bridges were heavily guarded by tanks, gun emplacements, and young soldiers with assault rifles. Except for military vehicles, the traffic was not crossing. Nothing ventured, nothing gained. We drove to one guard position and asked, in our best mixture of Russian, English, and sign language, if we could cross. The soldier on the driver's side of the car, after pointing his weapon at us and eyeing the passengers,

disinterestedly waved us through. The soldier on the other side of the beetle seemed to disagree. We decided to go ahead and leave the soldiers to "talk it out." It was an anxious moment, but we drove across the bridge and never looked back. The soldiers on the far end of the bridge thought that if it was okay to let us on the bridge, it was certainly okay to let us off. We drove through the guard position at a modest speed, looking for street signs to point us on our way to Rudna. There were none. The Czechs had removed most of the street signs and highway signs to cause problems for the Russians.

Actually we found the right road to Rudna with little difficulty just by counting blocks on our city map. We were making good progress when we encountered a 10-car traffic jam. Two tanks were blocking the road, and a tank commander was motioning for the cars to turn around and go back. He was not allowing anyone to pass. We didn't know what to do. We were off of our map, but we had noticed a side road a mile back and decided to try taking it in hopes of going around the roadblock. Since the road didn't go very far, we had to turn around. Then we noticed a Czech on a motorcycle beside the road. He gestured for us to cross a cultivated field. We followed the tracks in the field. At one point we almost got stuck, but finally we came out of the woods onto the road to Rudna about a half mile beyond the roadblock.

When we arrived at Rudna, only five cars were there, all Americans and Brits. The diplomatic representative had not yet arrived. I purchased some candy bars and food at a small store in case we were stranded in the countryside for a long time. The embassy staff member arrived, accompanied by a truck carrying a load of full five-gallon gasoline cans. We gassed up all the cars, which by then numbered around 50, and drove toward West Germany via Pilzen. We occupied ourselves by counting tanks and armored vehicles, which in this sector were mostly East German. We crossed the border without incident. Fortunately for us, the invaders were anxious to have all foreigners leave the country. Warner, who was attending the same congress with his wife, was staying in another hotel