Pennsylvania Silicification of Shallow Marine Fossils in the Jemez Mountains, New Mexico

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The frequently red silicification of northern New Mexican Pennsylvania fossils, especially brachiopods, is well-known to collectors but, as of yet, has not been described in detail or explained in the geological literature of New Mexico. In general, the process is interpreted as early, shallow burial, replacement diagenesis produced in calcite skeletons surrounded by marine water enriched in dissolved silica. Usually, fossil shells in limestones are silicified, while the enclosing calcite matrix is not. This is because replacement silicification is favored in the microscopic environments in the shell that contain organic matter, which upon decay, produces the more acidic conditions necessary for silica precipitation concomitant with calcite dissolution. Pore-water enrichment is ascribed to episodic increases in dissolved silica, principally produced either by variations in the delivery of primary silica by rivers or by changes in the delivery of wind-blown dust, which could be climatically controlled. Two occurrences that have been linked to red silicification at other localities are not petrographically abundant in these rocks, namely sponge spicules or pyrite.

All four of the Pennsylvania formations exposed in the Jemez Mountains contain silicified fossils in concentrations that vary between 15% and 25% of total specimens. Usually, only some of each calcite shell or skeletal part is replaced by silica. Silicification that is just below the outer layer of a brachiopod shell is usually red. If it is within the shell's outer layer, it is light gray and produces distortion of the shell's surface, frequently in the form of beekite rings. When shells were partially crushed by differential compaction, silicification preceded shell breakage. The red color of the silicification that is dominant in the Virgilian Jemez Springs Shale is ascribed to the presence of ferric iron in the silica, of unclear origin. Older Pennsylvania formations in the Jemez Mountains contain about an equal number of gray-silicified as compared to red-silicified fossils, in both shale and limestone lithologies. Along with brachiopod shells, crinoid stems and sea urchin spines are commonly silicified. Rare mollusk shells are not silicified.

Silicification of these fossils during the Pennsylvania occurred in diverse environments, especially if it is assumed that changing water depth was the dominant influence on sediment deposition in northern New Mexico. In these Jemez Mountain rocks, it is not true that fossil silicification is more common in limestones than in shales. In fact, in three cycles of alternating shale and limestone in the Morrowan Osha Canyon Formation, the average percentage of silicified specimens is 15% in the shales, but only 3% in the limestones. However, the level of silicification is greater in the marly (shallower?) southern exposures of the Jemez Springs Shale than it is eight kilometers to the north. It is unclear, therefore, if water depth has any effect on silicification. Further research is needed to answer this and other questions, such as the connection between fossil silicification and chert formation or whether there are any signs of cyclicity during the Pennsylvania Period in northern New Mexican rocks.