

Manganese Oxide Production at Onneto Yunotaki Falls

The combination of hot water, metallic ions, microbes, and oxygen at the falls creates a unique environment that produces manganese oxide.

Hot water and manganese ions

As rainfall seeps into the Yunotaki Lava Flow and is heated by volcanic activity below the surface, manganese mineral deposits in the lava dissolve into the water as Mn^{2+} ions. Hot water containing the manganese ions flows out from the springs at Onneto Yunotaki Falls.

Cyanobacteria and oxygen

Cyanobacteria, also known as blue-green algae, grow in the water and form a carpet-like layer, called a microbial mat, on the surface of the rocks. Cyanobacteria are microscopic organisms that often grow in large colonies, making them visible to the naked eye. They thrive in nutrient-rich environments with warm water and a lot of sunlight, exactly like Onneto Yunotaki Falls. Through photosynthesis, the cyanobacteria use the sunlight to convert water and carbon dioxide into carbohydrates that feed the algae. Oxygen is discharged into the water as a byproduct.

Manganese-oxidizing bacteria

The carpet of cyanobacteria is a habitat of many microbes, including manganese-oxidizing bacteria. The water at Onneto Yunotaki Falls contains a relatively high density of manganese ions (3 parts per million) due to having seeped through the Yunotaki Lava Flow. The bacteria cause the manganese ions and oxygen to react, forming manganese oxide, an inorganic, blackish-brown solid compound. Manganese oxide accumulates on the surface of the water and settles into the layer of cyanobacteria covering the rocks under the falls, turning the rocks black.