16.3E: Cold-Seep Ecosystems

A cold seep is an area of the ocean floor where hydrogen sulfide, methane, and other hydrocarbon-rich fluid seepage occurs.

Learning Objectives

• Outline the organisms that live in cold-seep ecosystems

Key Points

• Cold seeps develop unique topography over time, where reactions between methane and seawater create carbonate rock formations and reefs.
• Types of cold seeps can be distinguished according to the depth, as shallow cold seeps and deep cold seeps.
• Organisms living in cold seeps are known as extremophiles.

Key Terms

• cold seep: A cold seep (sometimes called a cold vent) is an area of the ocean floor where hydrogen sulfide, methane, and other hydrocarbon-rich fluid seepage occurs, often in the form of a brine pool. “Cold” does not mean temperature of seepage is lower than surrounding sea water. Actually, its temperature is often slightly higher.
• topography: A detailed graphic representation of the surface features of a place or object.
• extremophiles: An extremophile (from Latin extremus, meaning “extreme,” and Greek philiā (φ), meaning “love”) is an organism that thrives in physically or geochemically extreme conditions that are detrimental to most life on earth.

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Cold seeps develop unique topography over time, where reactions between methane and seawater create carbonate rock formations and reefs. These reactions may also be dependent on bacterial activity. Ikaite, a hydrous calcium carbonate, can be associated with oxidizing methane at cold seeps.

Types of cold seeps can be distinguished according to the depth, as shallow cold seeps and deep cold seeps. Cold seeps can also be distinguished in detail, as follows: oil/gas seeps, gas seeps, methane seeps, gas hydrate seeps, brine seeps, are forming brine pools, pockmarks and mud volcanos.

Organisms living in cold seeps are known as extremophiles. Biological research in cold seeps and hydrothermal vents has been mostly focused on the microbiology and the prominent chemosynthetic macro-invertebrates. Much less research has been done on the smaller benthic fraction at the size of the meiofauna (<1 mm).

Community composition’s orderly shift from one set of species to another is called ecological succession. The first type of organism to take advantage of this deep-sea energy source is bacteria. Aggregating into bacterial mats at cold seeps, these bacteria metabolize methane and hydrogen sulfide (another gas that emerges from seeps) for energy. This process of obtaining energy from chemicals is known as chemosynthesis.

![Figure: A Beggiatoa bacterial mat at the Blake Ridge](https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/16%3A_Microbial_Ecology/16.3%3A...)

During this initial stage, when methane is relatively abundant, dense mussel beds also form near the cold seep. Mostly composed of species in the genus Bathymodiolus, these mussels do not directly consume food. Instead, they are nourished by symbiotic bacteria that also produce energy from methane, similar to their relatives that form mats. Chemosynthetic bivalves are prominent constituents of the fauna of cold seeps and are represented in that setting by five families: Solemyidae, Lucinidae, Vesicomyidae, Thyasiridae, and Mytilidae.
This microbial activity produces calcium carbonate (CaCO₃), which is deposited on the seafloor and forms a layer of rock. During a period lasting up to several decades, these rock formations attract siboglinid tubeworms, which settle and grow along with the mussels. Like the mussels, tubeworms rely on chemosynthetic bacteria (in this case, a type that needs hydrogen sulfide instead of methane) for survival. True to any symbiotic relationship, a tubeworm also provides for their bacteria by appropriating hydrogen sulfide from the environment. The sulfide not only comes from the water, but is also mined from the sediment through an extensive “root” system a tubeworm “bush” establishes in the hard, carbonate substrate. A tubeworm bush can contain hundreds of individual worms, which can grow a meter or more above the sediment.

Cold seeps do not last indefinitely. As the rate of gas seepage slowly decrease, the shorter-lived, methane-hungry mussels (or more precisely, their methane-hungry bacterial symbionts) start to die off. At this stage, tubeworms become the dominant organism in a seep community. As long as there is some sulfide in the sediment, the sulfide-mining tubeworms can persist. Individuals of one tubeworm species Lamellibrachia luymesi have been estimated to live for over 250 years in such conditions.