



Copper, Bioavailability, and the Environment

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HOW DOES COPPER GET INTO THE ENVIRONMENT?

Copper is a natural element in the Earth's crust. As rocks erode, copper is released and is present everywhere (water, soil). Copper has been incorporated into living organisms throughout the evolutionary process and is now an essential trace element. Beginning with the Bronze Age over 7,000 years ago, humanity has put copper to use to advance civilization. As a consequence of mining, refining, and using copper in many products, some copper has been released into the environment, but modern technology has greatly reduced these levels.

IS THIS RELEASED COPPER HARMFUL TO THE ENVIRONMENT?

The degree that this released copper can be harmful varies with local conditions. Early laboratory studies of toxicity to aquatic organisms were performed in artificial media that were not representative of natural waters. Although not known at the time, these tests eliminated the conditions or factors in natural waters that reduced the bioavailability of copper, i.e., its potential to cause toxicity to aquatic organisms.

WHAT IS BIOAVAILABILITY?

Bioavailability is the concept that not all forms of a substance interact equally with aquatic organisms. When a metal is involved, in this case copper, bioavailability refers to the portion of the total metal in an aquatic system that binds to physiologically active surfaces and/or passes across a membrane into an organism.

CAN WE PREDICT THE LOCAL CONDITIONS OF BIOAVAILABILITY IN WATER?

The main factors that control copper's bioavailability to organisms in natural waters include constituents (e.g., natural organic matter) that bind copper and make it non-toxic and other constituents that prevent copper from getting into aquatic organisms like fish, including water hardness and natural acidity. All of these constituents vary greatly from one water body to another.

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COPPER

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DO GOVERNMENTS RECOGNIZE THE VALIDITY AND ACCURACY OF THESE MODELS AND USE THEM IN SETTING SAFE LEVELS OF COPPER IN WATER STANDARDS?

Yes. The US Environmental Protection Agency (EPA) has adopted the approach that a prediction of the local bioavailability of copper [based on the Biotic Ligand Model (BLM)] should be used in setting the local Ambient Water Quality Criteria (AWQC) for copper in freshwater. Canada and China are reviewing the US and European Union (EU) BLM-based approaches to predict copper bioavailability for establishing their freshwater standards.

CAN BIOAVAILABILITY SET SAFE THRESHOLDS FOR SOIL, SEDIMENT, AND MARINE WATERS?

The European Union has approved the voluntary risk assessment for copper products, declaring No Risk in water, soils, and sediment, based on the bioavailability principle. China is also considering soil standards based on bioavailability. In the US, the Copper Development Association and the International Copper Association are actively engaging the EPA to advocate the adoption of a BLM for coastal waters, now nearing completion, as the basis for a revision of its saltwater AWQC, and are cooperating with the EPA regarding the requirements for an estuarine BLM for possible brackish water criteria.