



HEAVY METAL

EARTH'S MINERALS AND THE FUTURE OF SUSTAINABLE SOCIETIES

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Kypros 29

Valeria Gisel Valle Martinez

For thousands of years, humans have relied on the unique properties of copper, a reddish-brown metal with an atomic number of 29, located between nickel and zinc on the periodic table. Alchemists represented copper with the symbol ♀, which was also used to denote the goddesses Aphrodite and Venus, and to signify the female gender. The metal was imbued with mystical properties, and used in a wide range of applications, from tools, jewelry and cookware to anti-microbial medicines. Today, copper is arguably the most important metal in the transition to renewable energy. With its high electrical conductivity, the metal is used in massive quantities for wiring. It is also used widely in pipes and plumbing, serving to conduct water, rather than electrons. Over the past century, copper production has increased rapidly across the globe, reaching more than twenty million metric tons in 2023. This massive quantity of extracted metal is associated with an even larger amount of waste rock—more than three billion metric tons annually—with the potential to create significant environmental and health impacts.

My country, Chile, is the world's largest producer of copper, accounting for about one third of global production, and more than twice that of the second biggest producer, Peru. Of the ten largest copper mines in the world, three are in Chile (Escondida, Collahuasi and El Teniente). My home in the central part of Chile is located near the Río Blanco Mine (Saladillo, Andes Mountain Range), where large amounts of copper are extracted from both underground and open-pit mining operations. As with all copper production in Chile, the Río Blanco Mine is run by the National Copper Corporation of Chile (Codelco), a state-controlled enterprise created following the nationalization of copper production by President Salvador Allende in 1971. Within a year of this nationalization (and partly as a result of it), Allende was dead, and his government replaced by a military dictatorship led by General Augusto Pinochet.

Despite his regime's strong tendency towards privatization, Pinochet maintained national control over the country's copper production, which remains to this day.

Beyond geography and nationality, I have another, more personal, relationship with copper. My family carries an altered gene that causes Wilson's Disease—a rare inherited disorder that causes a buildup of copper in the liver, brain and other vital organs. If undetected and untreated, the excess copper can create a wide variety of health problems, including tiredness, loss of appetite, fluid build up in the limbs, and sleep and speech disorders. My cousin Rodolfo died from this disease; it was tragic to see his body transformed and his life extinguished through copper poisoning.

When I was invited to participate in the *Heavy Metal Suite*, I jumped at the chance to represent my country in this international project, bringing my own perspectives to a global exploration of Earth's mineral resources. Since 2019, my work as a composer has focused on using music to mobilize scientific information in a manner that is creative and accessible to broad public audiences. In collaboration with marine scientists at the San Ignacio del Huinay Foundation, I have recorded soundscapes at a coastal marine field station in central Chilean Patagonia, creating sonic representations of a changing ecosystem impacted by rapid glacier retreat. I have also worked at the Federico Albert Taupp fish farm, creating sound maps of the artificial aquatic environment and its captive salmon population. This fish farm, established in 1905, is the oldest in Chile, and one of the oldest in South America. It also happens to be very close to the Río Blanco Mine, and this has allowed me to closely see (and hear) how copper extraction operates.

In composing *Kypros 29*, I wanted to represent the different stages of copper extraction and processing. The piece consists of eight parts: exploration, extraction, crushing, grinding, flotation, smelting, electro-refining and tailings management. Each part is interconnected melodically through the incorporation of repeating notes, Ab, Bb, F, Gb, C, Eb, taken from Augusta Read Thomas's *conductivity* motif. I also wanted to reflect the intrinsic chemical properties of copper, and the need for large quantities of water in its extraction and processing. The movement is written in the key of C (also

known as Do), representing the chemical symbol of copper, Cu. Water is represented through the use of the base note H (for H₂O), which is the German representation of the note B (also known as Si). Within the C major scale, the notes C (Do) and H (B or Si) represent the 2nd and 9th intervals, together forming 29, the atomic number of copper. The distance between these notes forms a major 7th interval, which is associated with musical dissonance, and can be taken to represent the conflicts that have arisen from the social and environmental impacts of copper mining in Chile. At the same time, the note Si resolves musically back to the root note of the C major scale. This resolution can provide inspiration in our quest for a truly circular economy, where metals can be reused and recycled, rather than continuously extracted from primary sources.

Kypros 29 is infused with the exploration and layering of various melodic elements, derived from the chemical properties of copper and the nature of its extraction and processing. At the same time, the music reflects the particular geography and climate of Chile's northern mining regions. Much of this territory lies in the high mountainous region of the Atacama Desert—one of the driest places on Earth, in a landscape of barren rocks shaped by sun and wind. This interplay of climate and geology is reflected in the instrumental sounds of the brass quintet, which range from light and airy to grounded and solid. This provides a metaphor for the challenges ahead, as we seek new mineral resources to harvest energy from the sun and wind.

Zinc

Yao Chen

In seeking to explore the relationship between humans and the environment, the *Heavy Metal Suite* bears features that reflect elements of a globally interconnected social and ecological system. There are threads of conductivity running through all the movements, written by composers from around the world who represent the