Geochemical Extraction of Ceratopsian Remains and Opal from Ironstone

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New prehistoric species, ancient hominid bones, potential martian astro-microbiology, and a wealth of soft tissues representing important evolutionary information are among significant specimens trapped within ironstone. Existing mechanical extraction remains time-consuming and causes substantial damage. Little research exists on non-destructive specimen extraction from ironstone. Experimentation generated chemical treatments for ironstone samples containing fossils and opals which removed the stone matrix in a time and resource efficient manner without damaging specimen inclusions. More than 168 samples were exposed to hydrogen peroxide, carbonic acid, hydrochloric acid, sodium hydroxide, and sodium bicarbonate. Changes to samples were assessed using Moh's Hardness, weight, scanning electron microscopy and partial energy-dispersive x-ray spectroscopy. Significant discoveries which maintain targeted specimen quality include four inclusion-specific processes for removing ironstone from fossils or gemstones. Hydrogen peroxide quickly reduces ironstone, but damages soft tissue and minimally affects bones. Hydrochloric acid is the most effective treatment for opal removal, but destroys fossils and soft tissue. Carbonic acid is the best balance of ironstone removal and preservation of fossilized bone or soft tissue. Sodium hydroxide is moderately effective for bone and opal removal, but damages soft tissue. The results are highly relevant to many researchers worldwide. These ironstone removal methods provide new, highly effective tools for accessing fossil specimens, potentially closing significant gaps in evolutionary knowledge. Furthermore, application of these processes has potential to drastically improve mining yields and efficiency in the soft gemstone mining industry.

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