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New concepts and evaluation tools in conservation of prehistoric caves, hints from Chauvet and other French cavities

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Preservation of cave wall paintings from Pleistocene poses the problem of robustness of remains against climate changes and recent anthropogenic impacts on cavities. Air/rock temperatures, air compositions and fluid transfers are used to test the stability of caves and to identify microclimates buffering mechanisms. Cave walls integrity deals with CO_2 dynamics as it pilots carbonates dissolution/precipitation and temperatures-pressure which govern water evaporation/condensation.

Long term (>15 years) monitoring in Chauvet, Pech Merle, Niaux, and Gargas caves substantiate previous evidence of underground stability. In the remote cavities, a closely equilibrated thermal environment (tenths of °C in seasonal amplitude, hundredths of °C air/rock gradient) is related to the rock volume inertia and to fluids percolation from surface. The small variations in air temperature correlated with barometric pressure were interpreted as isothermal exchanges with rock volume.

We show that large amount of gazeous biogenic CO_2 from soil and epikarst is transferred downward as part of biphasic flow with rainwater. In caves, it generates seepage of saturated water and air inlet equilibrated with soil atmospheres (CO_2 : 0.5 to 4% Vol., O_2 : 17 to 20.9 % Vol., humidity near saturation). Therefore, negligible physicochemical gradients at the air/rock interface protect the remains and their supports from evolution.

Air production from caves walls (Orgnac estimates from 0.007 to 0.04 $l.s^{-1}.m^{-2}$) is advected along subterranean large voids networks and limits direct outside airflow influence. Near the natural openings, aeraulic active interfaces separate underground confined systems where preservation conditions are optimal from cave segments open to surface influence where energy dissipation, phase changes and chemical exchanges induce intense wall weathering.

In some cases, fluid transfer quantification allows a rough evaluation of karst areas and volumes connected with cave systems.