

Por otro lado, los espeleotemas carbonáticos también han tenido un lugar destacado en esta Tesis. Es el caso de los espeleotemas ambarinos de la Cueva de El Soplao (Cantabria) cuya espectacular coloración ha sido relacionada con lixiviados procedentes de estratos de materia orgánica fósil y con los yacimientos de ámbar recientemente descubiertos en el entorno de El Soplao. Su compleja mineralogía compuesta por capas de calcita ambarina y aragonito así como sus características geoquímicas e isotópicas han sido estudiadas con el fin de conocer los cambios ambientales acontecidos en la cavidad durante su formación. Otros espeleotemas singulares de la Cueva de El Soplao también han sido examinados, como es el caso de las coladas aragoníticas con intercalaciones de arcillas cementadas o las costras ferromangánicas que aparecen sobre paredes y techos, y cuyo origen está relacionado con la alternancia de condiciones vadosas y freáticas en la cueva. En el caso particular de los materiales detríticos atrapados en el interior de las coladas aragoníticas se han relacionado con eventos de avenidas que arrastraron y movilizaron materiales endokársticos en la Cueva de El Soplao, especialmente en torno a 400 ka BP.

En relación a este tipo de espeleotemas peculiares, también se ha examinado la mineralogía además de la composición química e isotópica de algunos depósitos de *moonmilk* de cuevas españolas como son la Sima de la Higuera (Pliego, Murcia), la Cueva del Agua (Iznalloz, Granada), la Cueva de los Apas (Sorbas, Almería) o la mencionada Cueva de El Soplao con el fin de deducir los mecanismos genéticos que los generaron y sus implicaciones paleoambientales. Finalmente, además de los depósitos ferromangánicos de la Cueva de El Soplao se han estudiado otros procedentes de la Sima de la Higuera, cuya tipología y génesis atienden a procesos totalmente distintos. En este caso, el carácter hipogénico del sistema dio lugar a un “*boxwork*” relacionado con la precipitación de minerales ferromangánicos por primera vez descrito en una cavidad.

En esta Tesis Doctoral se demuestra el enorme potencial que presentan los espeleotemas yesíferos y carbonáticos como indicadores paleoclimáticos a partir del estudio de sus características mineralógicas, geocronológicas, geoquímicas e isotópicas.

ABSTRACT

Over the last decades, the geochemical records obtained from speleothems have been essential features in research about past climate changes. Studies have mainly focused on the analysis of carbonate speleothems. However, scarce attention has been paid to other types of mineral concretions.

In this Thesis, the use of gypsum speleothems as palaeoclimate proxies has been postulated. On the one hand, gypsiferous concretions have been proposed as indicators of concrete conditions occurred in caves as a consequence of their environmental specificity. On the other hand, the geochronology, the isotopic signal, the trace element concentration, the crystallography and the mineralogical characteristics of some of the most outstanding specimens of gypsum speleothems worldwide, both subaerial and phreatic have been examined in order to obtain palaeoclimate records.

For example, the peculiar speleothems from the Cueva de las Espadas of the Naica Mine (Chihuahua, Mexico) have revealed oscillations in the relative position of the water table as well as isotopic, salinity and temperature changes in the aquifer of Naica over the past 60 ka. Such fluctuations have been studied from the mineralogy, stable isotopes composition and trace elements concentration of these speleothems that are linked with climate changes occurred during that period, such as the Older Dryas and the 8,2 ka event. The geochemical outcomes suggest that changes in the main humidity source (Pacific/Gulf of Mexico) took place during the Late Glacial/Holocene boundary, in relation to regional-scale climate forcing. On the other hand, the selenitic megacrystals of the Giant geode of Pulpí (Almería, SE Spain) have been examined. These huge gypsum crystals precipitated from a mixture of fresh meteoric water with minor contribution of marine water. Simultaneously, that solution underwent changes in temperature and chemical composition in the hydrothermal system of Pulpí.

In addition, subaerial gypsum speleothems from the gypsum karst of Sorbas (Almería) have been studied. Both isotopic composition and trace element concentration have revealed that climate changes took place in southeast Iberian during the Late Bronze Age and the Roman Period (3000-1500 yrs BP). This results point to typical Mediterranean climate (warm and dry) conditions occurred around 2800 yrs BP. Later, regional climate evolved to wetter and probably colder conditions during the "Roman Humid Period". The relatively fast growth rate of subaerial gypsum speleothems turns them into high resolution proxies for palaeoclimate reconstruction.

Carbonate speleothems occupy also a prominent place in this Thesis. For example, the amberine speleothems that were recently discovered in El Soplao Cave (Cantabria, North Spain) have been studied. The striking dark color of these stalactites comes from leachates of fossilized organic material hosted in the carbonaceous Urgonian facies of the host rock. On the other hand, alternating bands made of calcite and aragonite reveal that periods of humidity and aridity occurred during the speleothem development. In addition, other singular speleothems appear in El Soplao Cave such as flowstones composed by aragonite laminas interlayered within successive thin strata of cemented silt and clay. These detrital layers are a consequence of palaeo-floods events that injected and mobilized sediments in El Soplao Cave especially around 400 ka BP.

In this Thesis it has been also examined the mineralogy, in addition to the chemical composition of some peculiar speleothems such as *moonmilk* deposits and ferromanganese deposits from several Spanish caves. The *moonmilk* deposits from de Cueva del Agua of Iznalloz (Granada, SE Spain), Cueva de los Apas (Sorbas, SE Spain), Sima de la Higuera Cave (Pliego, SE Spain) and El Soplao Cave have been studied in order to deduce their genetic mechanisms and palaeoenvironmental implications. Finally, two different types of ferromanganese deposits from El Soplao Cave and the Sima de la Higuera Cave have been also examined. The El Soplao's crust generated by alternating vadose and epiphreatic conditions that lead to precipitation of Fe-Mn oxides, whereas the ferromanganese deposits of Sima de la Higuera Cave are essentially corrosion residues which precipitation gave rise to peculiar "*boxwork*" formations and acid corrosion forms.

This Thesis demonstrates the great potential of gypsiferous and carbonate speleothems as palaeoclimatic indicators by studying their mineralogy, geochronology and geochemical characteristics.