

Pre-Historic Music and Art in Palæolithic Caves

Pech Merle is a cave (grotto) near the small village of Caberets, which is located on the western edge of the Massif Central in the southern, Midi-Pyrénées Region of France, in the Departement (County) of Lot. (Quercy is the pre-Napoleonic name of this Departement, which is still in popular use today.) The location of Caberets relative to other places in France is shown in Figure 1 below.

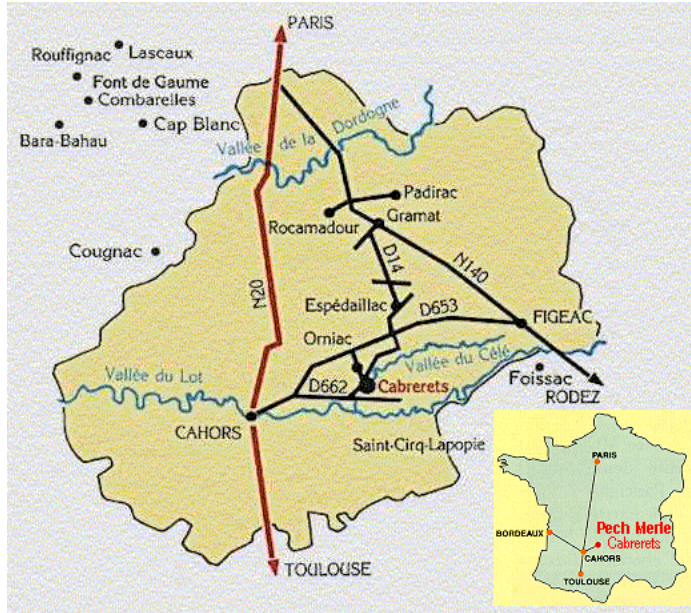


Figure 1: Map of the Departement (County) of Lot, in Southern France showing the location of the Grotte du Pech Merle, near the small village Cabarets

The cave is at an elevation of 280m on the eastern side of a hill called Pech Merle just outside the village of Caberets. The location of the Grotte du Pech Merle site is indicated by the red arrow in the photo below. Note the white limestone evident throughout the area.



Figure 2: Location of Grotte du Pech Merle (red arrow) relative to Caberets.

Pech Merle was discovered in 1922 by two teenagers, André David and Henri Dutertre, then 16 and 15 years old, respectively. A photo of André David is shown below.



Figure 3: Photo of André David exiting a cave near Cabarets, France.

Immediately following the discovery of the Grotte du Pech Merle, an examination of the wall paintings and engravings inside the cave was carried out by Father Amédée Lemozi, the priest of Cabrerets at that time. The galleries of the Grotte du Pech Merle are on average approximately 10 m wide and the height of the ceilings varies from ~ 5 to 10 m. There are two levels of the cave, but there are only paintings on the first level. 300 m of the walls are painted, and have been dated as being ~ 20,000 – 25,000 years old.

Why is this cave called "Pech Merle"? In the lower third of France is a southern Latin culture called Languedoc or Occitan. Pech is the French writing of the Occitan word puèg which means a hill. We pronounce the word pech as in "fresh". This word appears in the name of many localities, written pech, puech, pioch, pey, and one can read it on many road signs in this region of France. In Old French, the word pech is puy, as in "Puy de Dome". Merle is sometimes translated as blackbird, and thus essentially, the English translation of Pech Merle is Blackbird Hill!

Figure 4 shows an aerial photo of the surface of the Grotte du Pech Merle site, with superimposed plan of the cave. Figure 5 shows a photo taken inside the Pech Merle cave, near the entrance. Note the red dots on the roof of the cave – they were placed there by prehistoric visitors to (or inhabitants of) the cave to indicate a zone of special acoustic significance - resonances! Figures 6-11 below show photos of some of the prehistoric drawings of animals and other figures that had been made at various locations on the walls of the Grotto du Pech Merle.

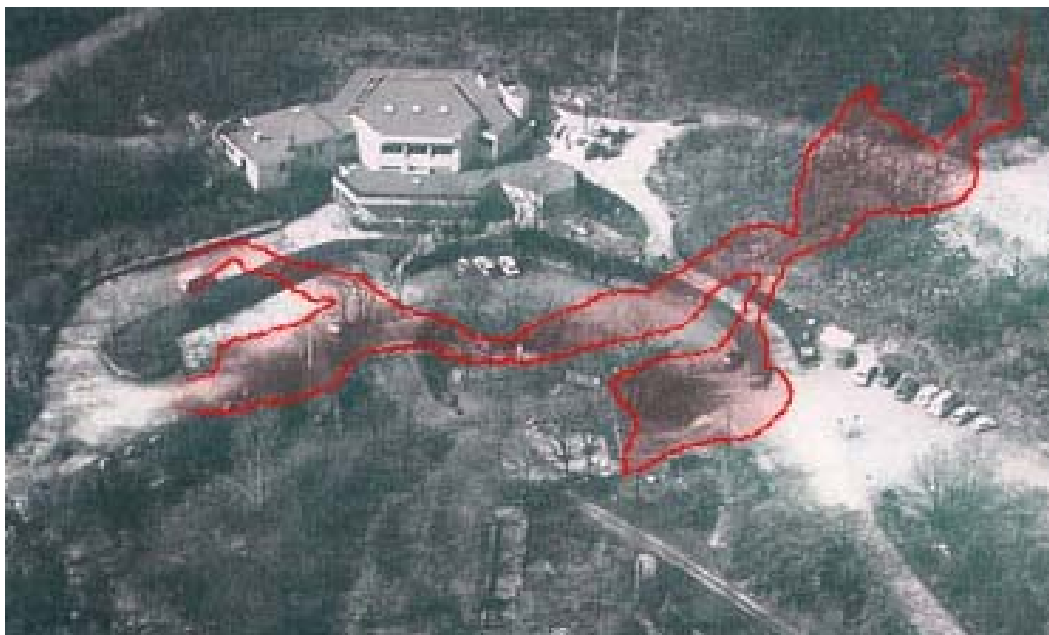


Figure 4: Photo of the surface of the Pech Merle site with superimposed plan of the cave.

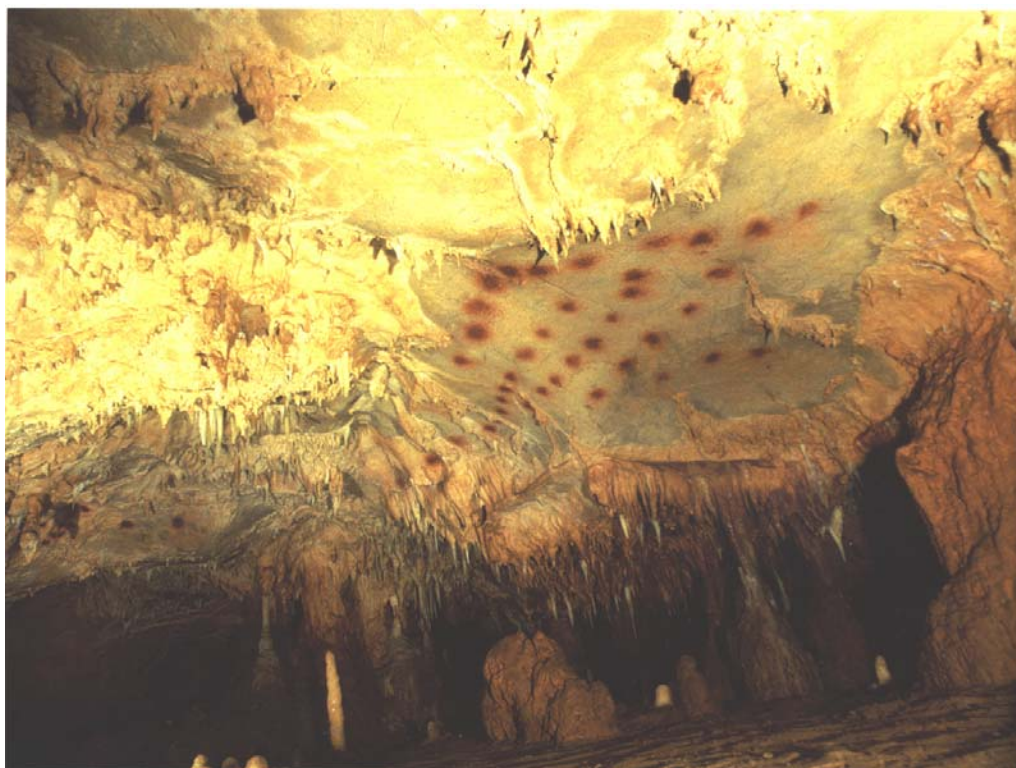


Figure 5: Photo of the inside of the Grotte du Pech Merle, near its entrance. The red dots on the roof of the cave indicate a zone of special acoustic significance – resonances!

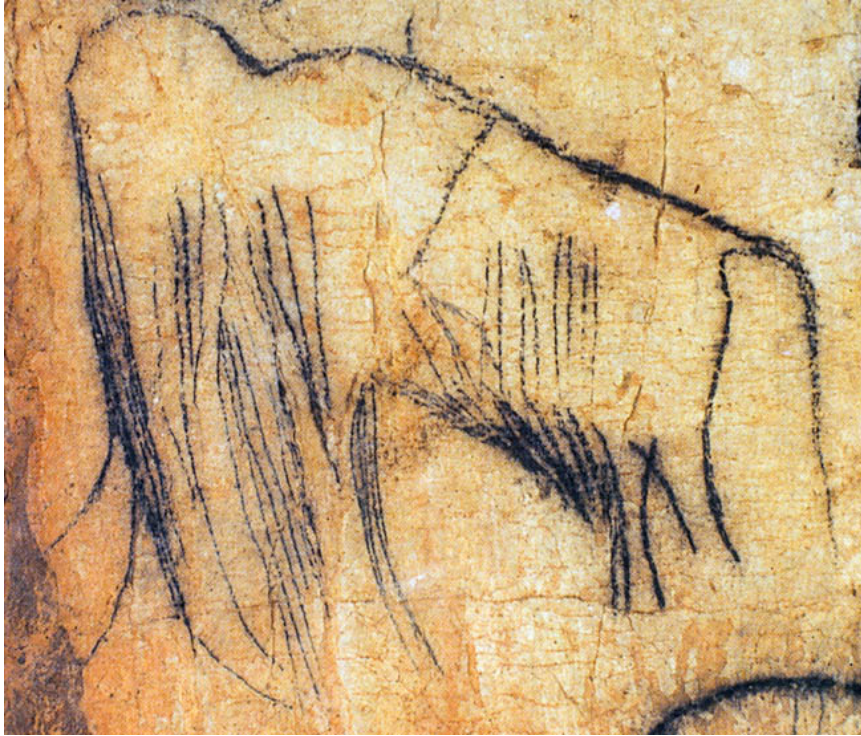


Figure 6: Photo of a drawing of a woolly mammoth at Pech-Merle. Photo: Agenda de la Préhistoire 2002-3. An attempt has been made by the prehistoric artist to indicate the beast's characteristic long heavy coat, and the domed head is clearly shown. The original drawing is about 31.5 inches long.

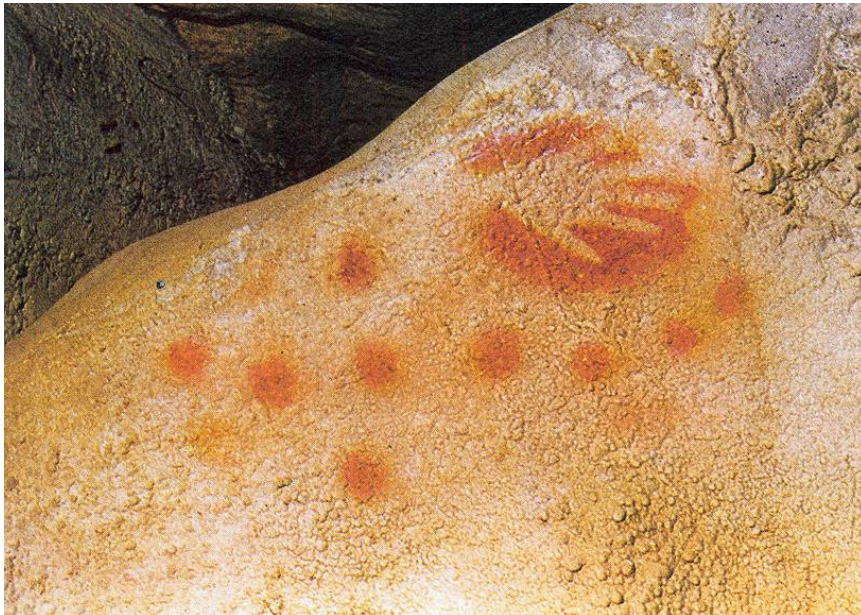


Figure 7: A photo of a hand stencil on the wall at Grotte du Pech Merle. Note again more of the red dots. Photo: Man before History by John Waechter



Figure 8: A photo of another drawing of a mammoth and a horse at Grotte du Pech Merle.



Figure 9: A photo of another, fancier drawing of a horse and hand-stencils at Grotte du Pech Merle. This fancy horse actually existed at that time – *i.e.* the drawing is not artistic license!



Figure 10: A photo of a stylized drawing of a female, and a mammoth at Grotte du Pech Merle. Again, note the presence of red dots!



Figure 11: A photo of a drawing of an auroch at Grotte du Pech Merle. Aurochs, like woolly mammoths, are now extinct.

Because of the limestone deposits in this area of southern France, there are many other caves in proximity to Grotte du Pech Merle – within a 10 km radius – however, these are not open to the public. The list of neighboring caves to Pech Merle includes: [1] Le Cuzoul des Brasconies, [2] La Grotte Carriot, [3] La Grotte Christian, [4] La Grotte des Faux-Monnayeurs, [5] La Grotte du Cantal, [6] Le Cuzoul de Mélanie, [7] La Grotte Marcenac, [8] La Grotte de Sainte Eulalie, [9] La Grotte du Papetier, [10] La Grotte du Moulin, [11] La Grotte de la Bigourdane, and [12] La Grotte de Pergouset. A map of the region showing where these caves are in relation to one another is shown in the following figure.

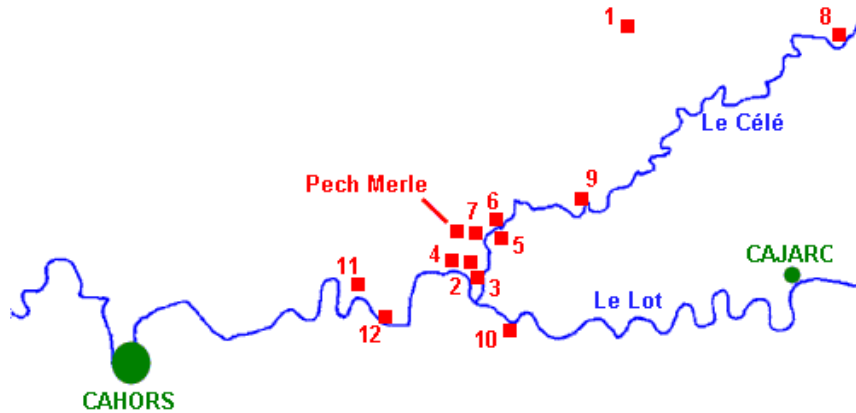


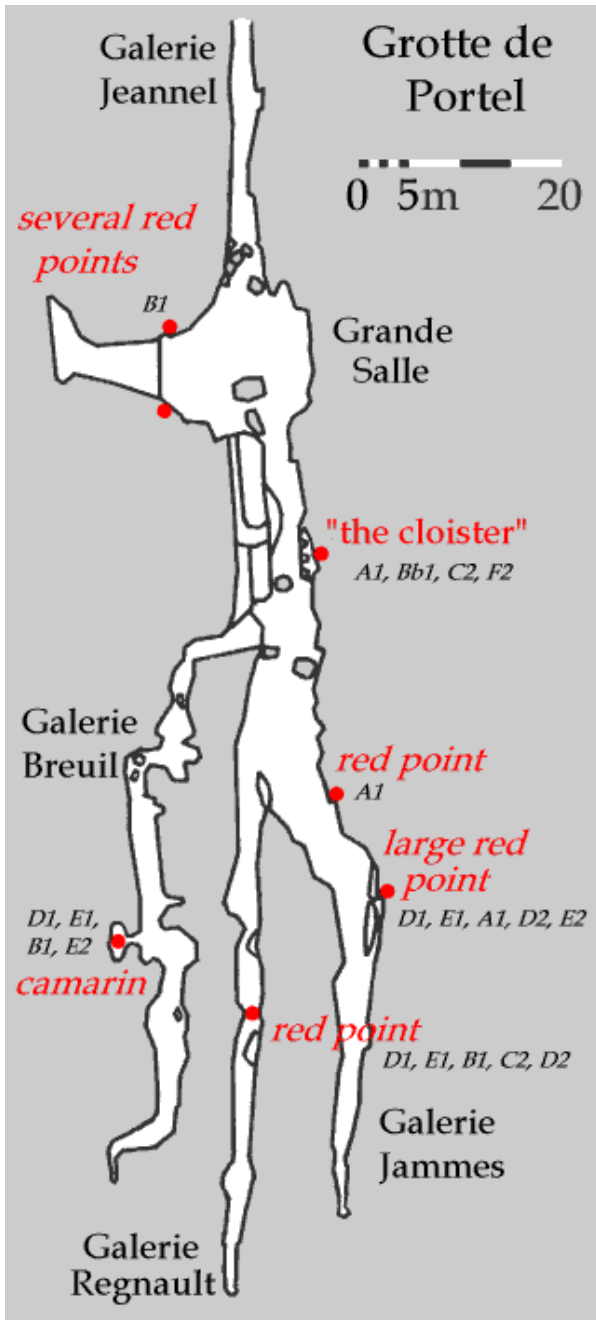
Figure 12: Map showing locations of nearby caves in the Province of Lot, Southern France.

Another cave system in this same region of southwestern France, Le Grottes de Cognac also contains images from the Palæolithic era. A total of 60 images of animals, 50 outlines of hands and 3 human images were found there. One such drawing is shown in the photo below.



Figure 13: A photo of a drawing of a large Ibex from the Cognac Cave in the Lot region of southern France. Photo: Agenda de la Préhistoire 2002-3.

Recent acoustic experiments carried out in some of the caves in southwestern France under the direction of Iégor Reznikoff have shown that in the majority of such caves, the presence of wall paintings and drawings is highly correlated with the phenomenon of natural echo at that location in the cave, and especially so at particular resonant frequencies. Furthermore, it has been established that indications relating to the nature of the particularly resonant sound are recorded not in the form of some kind of random graffiti, dispersed at the whim of the prehistoric artist, but instead as precisely-coded signs within the pictorial representation, often explicitly indicated by means of lines or dots emerging from the mouth of a person or animal drawn, in precisely those areas of the cave where the echo is most pronounced!



Three caves in the Departement of Ariège – also in the Midi-Pyrénées Region in southwestern France – Niaux, Le Fontanet and Le Portel – were investigated by Reznikoff’s research group for their acoustical properties. Their experiments were primarily focused on measuring the intensity and duration of sounds, and more generally, with the way the resonances varied in relation to the point of emission. The sound data for Le Fontanet showed no significant variation – likely because the original entrance had been blocked by post ice-age rock debris, effectively transforming the “open-closed ends” organ-pipe acoustical properties of this cave into an organ pipe with both ends closed – thus drastically changing the resonant properties of this cave. However, the sound data at both Le Portel, which has three entirely separate galleries, and Niaux, which is an exceptionally large cave system, provided a clear set of results. Note also that the configuration of these two cavern systems has changed very little since the Palaeolithic era.

The figure on the left shows a map of the cave system at Le Portel, taken from ref. [3]. The map, constructed by Resnikoff and Davois showed a total of 35 points of resonance had been found in the cave at various frequencies. In this figure, red dots mark points of the most spectacular resonances; these points are *also* associated with cave paintings at those locations – most of the cave paintings are within a meter or so of these resonance points! The musical notes (*i.e.* frequencies) associated with each resonance point are also indicated on this map.

Figure 14: Map of the cave system at Le Portel, Southern France, indicating the locations of the most spectacular resonance points in the cave and the notes (*i.e.* frequencies) associated with the resonances at those locations. From: "La Dimension Sonore des Grottes Ornées" (Iégor Reznikoff et Michel Davois, Ref. 3) .

The existence of acoustic resonance(s) in the caves is not in itself surprising. However, the significance of their studies becomes apparent when the authors compare their points of resonance with the location of the cave paintings. They draw three main conclusions: First, most of the cave paintings are located within one meter of points of resonance! Note that the Grande Salle at Le Portel, for example, which gave no resonance response, also has relatively few paintings. Second, most of the points of resonance correspond to locations with cave paintings. Indeed, the *best* points of resonance are *always* marked in this way. Finally, the authors claim that the location of some of the paintings can be explained *only* by the resonance(s) at that particular cave location. A good example of this is “the cloister” area at Portel (see figure) where a particularly effective point of resonance is marked by red painted dots, as there is not enough room for a full painted figure.

For the prehistoric visitors to such caves, exciting such cave resonances must have been all the more striking in the flickering, dim light provided by simple lamps and/or tapers used by the original artists.

While it is most likely that the humans visiting these caves excited these resonances with their own voices, either as simple notes, or perhaps to mimic the sounds associated with the animal figures drawn in proximity to these resonant points in these caves, it is also plausible that e.g. primitive drums, flutes and/or whistles may also have been used in cave rituals – bone flutes have been found at several Palæolithic sites in Europe of roughly the same age as these cave paintings. Thus, prehistoric musical instruments of these types may also have been used to excite the cave resonances by these people.

We can learn some interesting things about the nature of the observed resonances at Le Portel by crudely modeling this cave as a single, open-closed organ pipe of length, $L \sim 130$ m. The resonant frequencies associated with longitudinal standing waves in an open-closed organ pipe are $f_n = n v/4L$, where $n = \text{odd integers: } 1, 3, 5, 7, \dots$ (for reference and/or comparison, the resonant frequencies of longitudinal standing waves both in open-open and closed-closed organ pipes are $f_n = n v/2L$, where $n = \text{integers: } 1, 2, 3, 4, 5, \dots$), and the speed of sound, $v \sim 345$ m/s at $T \sim 20$ C. The fundamental mode of a open-closed organ pipe of this length has a frequency $f_1 \sim 0.7$ Hz, which is extremely low in comparison to the various resonant frequencies indicated on the map of Le Portel. Thus, e.g. the A1 (~ 55 Hz) B1 (~ 62 Hz), D1 (~ 73 Hz), E1 (~ 82 Hz), etc. cave resonances that can be excited by the lower range of the human voice are either high-order odd harmonics of the fundamental associated with the entirety of the Le Portel cave system, or they could instead be low-order harmonics of resonances associated with the local cave geometry – i.e. the *transverse* dimensions $L \sim 5$ - 6 m of the cave in the local vicinity would be the dominant factor. For this latter situation, resonant frequencies (very crudely) would be of the form $f_n \sim n v/2L$, with $n = 1, 2, 3, 4, \dots$ and for $L \sim 5$ (6) m, the fundamental frequency ($n = 1$) would be $f_1 \sim 34$ Hz (28 Hz), respectively – thus cave resonances e.g. at B1 and A1 could be understood as the 2^{nd} harmonics of these, i.e. $n = 2$ excitations for $L = 5$ m and 6 m, respectively. However, note that this latter possibility is apparently at odds with Reznikoff, *et al.*'s acoustic studies in the cave at Le Fontanet.

It really must have been quite good fun for the Palæolithic visitors to these caves in southern France making sounds and singing in dimly-lit conditions at these especially resonant locations inside these caves, ~ 20 - 25 thousand years ago, apparently painting

images and other symbols and markings in these locations. The reverberant/resonant acoustical properties of these caves must have seemed mystical, if not magical (or even supernatural) to them, not having any quantitative understanding of these physical phenomena. Obviously, the lack of such an understanding did not at all deter them from having a good time there!

Perhaps these occasions were the world's first "rock" concerts – singing and playing musical instruments inside of a gigantic, complex, multiply-connected organ pipe, exciting complex resonances and echoes as they sang and played! They were actually inside a naturally-formed musical instrument of gigantic proportions! Most definitely this was the world's first example of underground music! Today, it is somewhat amusing that we seem to have lost the appreciation of this simple pleasure of nature. Or have we? In the Middle Ages, great cathedrals were built, great choirs have sung and music of various kinds has been played in these buildings throughout the centuries!

These underground caverns function as immense echo chambers – their naturally-formed vaults are capable of producing sounds similar to those that can be heard in the most famous cathedrals and chapels in Europe, such as the Baptistry di Pisa, in Pisa, Italy – a round, cylindrically-shaped building with a dome on it, located near to the famous Leaning Tower (Bell Tower) and the Duomo Pisa (Cathedral of Pisa), as shown in the figure below.



Figure 15: The Baptistry, Cathedral (Duomo) and the Leaning Tower of Pisa.

In order to better convey the full sense of what must have been a very powerful aural/sonic experience for Palaeolithic man in making animal and musical sounds at various resonant locations in these caves in southern France ~ 20-25 thousand years ago, for the benefit of

those who have not visited the Baptistry of Pisa, and sonically/aurally first-hand witnessed the demonstration of the amazing acoustical properties of this building by one of the attendant guards, I will describe my own experience.

In 1982, my wife and I visited friends in Pisa, and so of course we also visited the Leaning Tower, the Cathedral (Duomo), and finally the Baptistry of Pisa. We were especially attracted to the latter, as we noticed many other visiting tourists going inside. This piqued our curiosity as to what was inside. Shortly after we entered the Baptistry, the guard inside asked us (in Italian) to all be quiet. After a short pause, when all the people inside had quieted down, the guard angled his head toward the dome of the Baptistry and sang, in succession, three notes of a major C triad – the highest note first G, then the middle note E, then the lowest note C, at the rate of roughly one note per second. These notes were not randomly chosen by the guard, but deliberately so chosen – they were apparently resonant frequencies of this building – but we tourists didn't know this at that point in time...

The totality of the sound associated with this man's singing of a major triad literally rose up, over a period of a few seconds, from the ground-floor interior portion of the Baptistry, and into the dome region of Baptistry, where it circulated and reverberated/swirled around in a 3-dimensional manner at the top of the dome – this effect was very clear/pronounced, and as it did so, the harmonic content and complexity of the sound also slowly evolved over time – apparently due to the frequency-dependent absorptive properties of the dome. The sound of this human-generated major triad evolved from what initially started off as recognizably human into a gloriously complex, temporally and spatially-changing sound that was beyond human – all of us tourists upon experiencing this were totally stunned and amazed! This rich, complexly reverberant sound circulating in the dome of the Baptistry of Pisa could still be heard after what seemed to be an amazingly long time – well over three minutes, it seemed! It was a fantastic experience!

Thus, one can now better appreciate the experience it must have been for Palaeolithic visitors to these caves in southern France, making sounds and singing in dimly-lit conditions at these especially resonant locations inside these caves, ~ 20-25 thousand years ago!

In Tibet, there are temples where for centuries monks have chanted at the resonant frequencies of the temple. If one e.g. "thunks" the side of these temples, indeed, they resonate at these chanted frequencies!

Today we have dedicated, scientifically-designed concert halls for people to enjoy music at. The author also smiles, remembering his own experiences recording country/folk-style music played on acoustic guitars with some friends in the concrete stairwell in the 12-story high Sanford Hall dormitory at the University of Minnesota back in the early-mid 1970s... Playing in this stairwell, effectively ~ 120 ft long, vertical closed-closed organ pipe was great fun – it had glorious echoes, wonderful resonant & reverberant properties!

S. Errede wishes to thank Pam Carsey, a local musician-friend of his here in Champaign-Urbana, for initially bringing to his attention the musical historical aspects of the Palaeolithic caves in southwestern France.

References:

- 1.) For more information about the Grotte du Pech Merle near Cabarets, France, see:
<http://www.quercy.net/pechmerle/english/introduction.html>
- 2.) Lucie Rault, "Musical Instruments: Craftsmanship and Tradition from Prehistory to the Present", Harry N. Abrams, Inc.
- 3.) Iégor Reznikoff and Michel Davois, "La Dimension Sonore des Grottes Ornées"
Bulletin de la Societe Prehistorique Francaise (Vol 85. p. 238-246, 1988).