Identifying dangerous CO2 concentrations in speleology

The flame method versus modern sensors

In natural caves CO2 is mostly not a common danger. The situation is different in abandoned mines, especially when aeration is diminished by closing of entrances and when rotten wood and fungi are present. This is unfortunately the case for the mines located in the french Minette, south of Esch. The CO2 concentration reaches over 2% in the deeper galleries and thus is very dangerous.

What are the effects of CO2?
A good information page is http://thelances.org/hr3/badair.html
Similar information is gathered in an Elektor article about measuring CO2.

In short:

CO2 concentration [ppm]	
ca. 400 = 0.04%	this is the normal concentration in air
>20 000 = 2%	severe danger
40 000 = 4%	concentration in breathed out air The body can no more get loose of CO2 and it is accumulated in the body.
50 000 = 5%	Loss of consciencesness

On our last underground trip we used an infrared absorbing CO2 sensor from Senseair and a cigarette lighter as a control. When the concentration got near 2%, we decided to go back. Amazingly at this concentration the lighter showed a very faint flame, nearly going out, thus agreeing to the warning of the CO2 sensor.

Back home I decided to investigate a little more on this concordance.

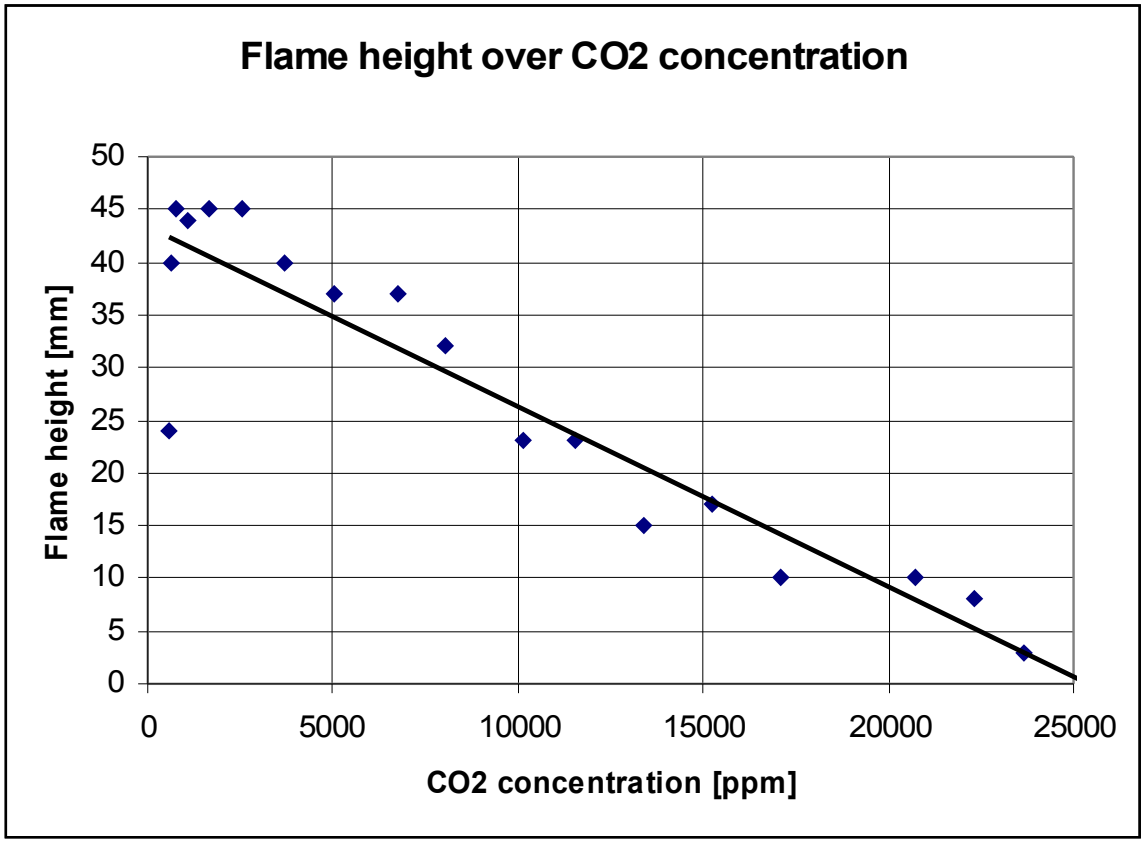
The experimental setup was quite simple: a candle was lit in a closed container, thus producing more and more CO2. The sensor measured the CO2 concentration.
Both candle and sensor display were photographed in 10s intervals with a digital camera.
Afterwards, concentration and flame hight could be analised to find a coincidence.

The results confirmed the observation in the mine.

			
0.16% still normal flame	0.8% flame length already diminished	1.5% flame length strongly diminished	2.2% flame nearly out

At 2.5% the flame definitively goes out.

Interestingly the flame length gives a good indication for the CO2 concentration.



Do these results mean that a cigarette lighter is a s good in measuring CO2 as an electronic sensor? At least the threshold seems to be quite near the critical level of 2%, though somewhat higher.
I will continue to use both methods, to be on the safe side!