CHANCE AND POSSIBLE CHARACTERISTICS OF EXTRATERRESTRIAL BAROMETRIC CAVE SYSTEMS: A. Pflitsch[1] and J. Ringeis[2], [1]Ruhr-University Bochum, Workgroup of Cave and Subway Climatology, Universitätsstr. 150, 44801 Bochum, Germany, andreas.pflitsch@rub.de, [2]Ruhr-University Bochum, Workgroup of Cave and Subway Climatology, Universitätsstr. 150, 44801 Bochum, Germany, julia.ringeis@rub.de.

Introduction & aims: Compared to the majority of caves where air flow is caused by temperature differences between the outside atmosphere and the air inside the cave, we do have so called barometric caves. The air flow of caves of this type is a result of atmospheric air pressure changes.

The question of the basic air flow mechanisms in barometric caves and the full size of both caves are the main aspects of a research project from the working group cave- and subway-climatology at the Ruhr-University of Bochum (Germany). [1], [2]

Genesis of air flow in barometric caves: Air pressure variations in the outer atmosphere usually enter a cave system quite quickly through its openings. Air pressure increase leads to a rising pressure inside the cave, falling air pressure outside to a decrease of pressure within the cave.

Short-term air pressure differences between the outer atmosphere and cave and air pressure exchange are not or hardly measurable in most cave systems. This holds especially true for small and middle-sized cave systems which either have a high number of openings or caves with a few small openings where quick air exchange is not possible. Even big cave systems with big openings show a quick air pressure exchange, but the air flow is mostly not detectable.

This is different for cave systems with an entrance that has a small cross section, compared to the size and volume of the cave behind the opening. The air exchange is restricted and a quick air pressure equalisation is not possible. This can be explained as follows: Starting with an even air pressure between cave and outer atmosphere, there is no equilibrating air flow.

If a high pressure system exists, the air pressure is rising outside the cave and an air pressure difference between cave and outer atmosphere arises. If the relation between the cave entrance and the cave volume is not favourable, a direct adjustment of air pressure will be impossible and, as a result of this, a relative overpressure occurs outside the cave. This pressure difference – with a relative under-pressure within the cave – leads to equilibrating air flow into the cave. This continues as long as an equilibrium situation is reached. If air pressure is still rising, the pressure difference rises too and the air flow increases as a consequence.

If the air pressure outside the cave is falling again the pressure difference between both systems decreases and the air flow speed decreases. In case these relations are even, air exchange stops. If the air pressure keeps falling, a higher pressure within the cave compared to that outside will result in the airflow being reversed from the cave to the outer atmosphere.

This process lasts as long as either enough air has flown out of the cave (i.e. an equilibrium situation has been reached) or until the air pressure outside rises again.

Passing and stationary pressure systems are macro-scale features with meso-scale variations and not micro-climatical phenomena. Therefore they influence a whole region and the whole cave system. The compensating air flow takes place at all cave openings at the same time. Rising air pressure outside means air flow into the cave, falling air pressure outside means air flow out of the cave. It is of no importance how many openings a cave has. The important factor is the relation of cave volume and the width of the cave openings. The more the disadvantage between these factors, the more the compensational effects are noticeable and measurable.

Furthermore, the cave structure and the macro and micro structures of the walls, which affect the turbulence of the airflow, are responsible for the duration and strength of the air exchange. Especially longer-lasting or very quick changes in air pressure, result in a rapidly rising pressure difference between cave air and outer atmosphere. This leads to long-lasting and intense compensating air flow.

If the cave structure represents one big unit, with wide corridors and halls, the compensating air flow can only be detected near the openings. If the cave structure is strongly jointed with several different parts, which are separated by narrow passage ways and tunnels, compensating air flows are detectable in many parts of the cave system.

Barometric Caves on other planets: But what does all this mean to extraterrestrial caves?

Regarding the caves in general, the influencing factors are the same as on the earth. The bigger the cave and the smaller the entrance, the stronger will be the expected affects. Major differences will depend on the density of the atmosphere and on the characteristics of the weather. Here the following factors need to be taken into account:

- The density of the atmosphere

- Atmospheric pressure differences
- Appearance of a diurnal climate, seasonal climate or specialities as a function of rotation and revolution.

In a thinner atmosphere the described balance will be considerably weaker due to a lower air density and weaker weather pattern. Contrary in a denser atmosphere stronger compensating effects can be expected. Here the changing viscosity of the atmosphere and mechanisms inside the cave need to be taken into account.

An example is the influence of melting or sublimating ice masses inside the cave by inflowing warm air or temporarily active thermal effects from inside the specific planet.

In the presentation previous research on earth and the inferred conditions and possibilities for caves on other planets are mentioned and put up for discussion.

References: [1] Pflitsch, A.; Willes, M., Horrocks, R. and Piasecky, J. (2010) About dynamic climatological processes of barometric cave systems in relation to the outside weather conditions and different cave structures. *ACTA CARSOLOGICA, Postojna, SL, 39/3, p. 449-462*. [2] Ringeis, J.; Pflitsch, A. and Piasecki, J. (2007) Luftdruck- und Strömungsverhältnisse barometrischer Höhlen – Untersuchungen in Wind Cave und Jewel Cave, Süd Dakota, USA. *Speläologisches Jahrbuch - Verein für Höhlenkunde in Westfalen, 2007, Jg. 24, Sonderausgabe anlässlich der Verbandstagung 2007 in Iserlohn, Iserlohn, p. 16-19.*