Geophysical Research Abstracts
Vol. 12, EGU2010-4631-2, 2010
EGU General Assembly 2010

The Himalayas of Nepal, a natural laboratory for the search and measurement of CO_2 discharge

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Large CO_2 flux has been found in the Trisuli Valley, North of Kathmandu, Central Nepal, in 2005. This leakage zone is located in the vicinity of the Syabru-Bensi hot springs, and is characterized by an average flux of CO_2 of 6500 ± 1100 g m^{-2} day^{-1} over an area of 15 m $\times$ 15 m (Perrier *et al.*, *Earth and Planetary Science Letters*, 2009). The site is also located close to the Main Central Thrust Zone (MCT Zone), one of the large Himalayan thrust, connected at depth to the Main Himalayan Thrust, the main thrust currently accommodating the India-Tibet collision (Bollinger *et al.*, *Journal of Geophysical Research*, 2004). Isotopic carbon ratios (δ^{13}C) indicate that this CO_2 may come from metamorphic reactions at about 15 km of depth (Becker *et al.*, *Earth and Planetary Science Letters*, 2008; Evans *et al.*, *Geochemistry Geophysics Geosystems*, 2008). Actually, this zone was originally found because of the large δ^{13}C found in the water of the hot springs suggesting degassing (Evans *et al.*, *Geochemistry Geophysics Geosystems*, 2008). In 2007, another zone of CO_2 discharge was discovered 250 m away from the main Syabru-Bensi hot springs. This new zone, located next to the road and easy to access all over the year, was intensely studied, from the end of 2007 to the beginning of 2009. In this zone, an average value of CO_2 flux of 1700 ± 300 g m^{-2} d^{-1} was obtained over an area of about 40 m $\times$ 10 m. Using CO_2 flux data from repeated measurements, similar flux values were observed during the dry winter season and the wet summer period (monsoon) (Girault *et al.*, *Journal of Environmental Radioactivity*, 2009). Thus, in addition to fundamental issues related to global CO_2 balance in orogenic belts and tectonically active zones, these small scale (100-meter) CO_2 discharge sites emerge as a potentially useful laboratory for detailed methodological studies of diffusive and advective gas transport. Recently, the search for further gas discharge zones has been carried out using various clues: the presence of a hot spring with high δ^{13}C, of H_2S smell, of hot spots in thermal images, of a geological contact, of self-potential anomalies (Byrdina *et al.*, *Journal of Geophysical Research*, 2009) or of large radon-222 flux. Preliminary results about the failures or successes of the various methods will be given in the Trisuli and Langtang valleys (Central Nepal), in the Kali Gandaki valley (Western Nepal) and in the Thuli Bheri valley (Lower Dolpo, Far Western Nepal). These various sites also offer an opportunity to test the optimal estimation of total CO_2 flux, using the least amount of experimental measurements. Preliminary results complemented by simulations will also be given on the total CO_2 flux. In parallel, monitoring methods are being studied in the Syabru-Bensi pilot site. First, CO_2 flux has been studied as a function of time using repeated measurements. Furthermore, the high radon content of the geological CO_2 allows cost-effective monitoring using BARASOL™ probes. More than two years of data are already available and give hints on the use of radon to follow CO_2 discharge as a function of time. These first results show how experimental studies carried out in natural discharge zones provide a rich laboratory to test the methodological approaches useful for CO_2 leakage and monitoring.