Identification of multiple gas components at fault zone in SW Taiwan and its application for earthquake surveillance

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Many hot springs and mud volcanoes are distributed along the tectonic sutures in SW Taiwan. Bubbling gases from hot springs in this area usually are CO_2-dominated with minor CH_4 and N_2 contents. Compiled the available data, at least four gas components can be identified in this area: (1) mantled-derived CO_2: high helium isotopic ratios (~7 *Ra*), low $CO_2/^3He$ ratios ($1\sim2\times10^9$), and high helium contents (>50 ppm); (2) crustal CO_2: low helium isotopic ratios (<0.2 *Ra*), high $CO_2/^3He$ ratios ($10^{11}\sim10^{13}$); (3) crustal CH_4: low helium isotopic ratios (<0.2 *Ra*), and high helium contents (>50 ppm); (4) dissolved air in saturated groundwater: $^3He/^4He \equiv 1Ra$, and very low helium contents (<1ppm). Most gas compositions of samples collected from this area can be well explained by mixing of above components with different proportions.

Except for samples from Chunglun (CL) and Kuangtzeling (KZL) areas, CH_4-dominated samples usually show relatively constant gas compositions. It indicates that they were mainly originated from crustal CH_4 reservoir, and were not disturbed by other components even big earthquake events occurred. In contrast, bubbling gases from CL and KZL hot springs have larger variations and indicate that they were mixed from different gas components. CL hot spring gases, especially, show extreme variations and clearly associated with earthquake events during last two years. It suggests that natural gases originated from multiple sources in suitable tectonic environment, the variations of gas compositions may be sensitive to earthquake events. CL area, hence, has been considered as one of the best locations in SW Taiwan for monitoring gas variations related to earthquakes. An automatic continuous gas surveillance station equipped with quadruple mass spectrometer (QMS) gas analyzer and radon detector had been setup for this purpose. Continuous monitoring results show that gas variations were closely related to the local earthquake and/or crustal stress events.