Sampling and gas purification for radio-noble-gas measurements in the environment: A review

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It has always been recognized that the precondition for any meaningful environmental tracer study is a proper sampling protocol. For any gas tracer but in particular for large volume radio-noble-gas analyses sampling becomes a crucial and sometimes also a limiting issue (IAEA, 2012, in press). In the past the required volume of water that has to be degassed in the field for ^{39}Ar or more recently for ^{85}Kr and ^{81}Kr analyses decreased steadily. First low level counting (LLC) ^{39}Ar measurements in groundwater required about 10 tons of water to be processed in the field (LOOSLI, 1983; LOOSLI et al., 2000). In the first ^{81}Kr study in the Great Artesian Basin (GAB) in Australia, measured by AMS(COLLON et al., 2000; LEHMANN et al., 2003), 0.5 cc Kr were collected at each site. This corresponds to a volume of about 17 tons of water. With the improvements of the existing analytical methods and the development of novel techniques (COLLON et al., 2004; DU et al., 2003; JIANG et al., in press) the sample volumes decreased and are expected to decrease further in the future. LLC ^{39}Ar sample olumes are today typically in the range of 1-2 tons of water whereas for LLC ^{85}Kr and Atom Trap Trace Analyses (ATTA) ^{85,81}Kr detection not much more than 100 litres of water are needed. Accordingly, the methods and tools for gas extraction in the field evolved. The classical vacuum extraction (PURTSCHERT, 2008; SMETHIE JR. and MATHIEU, 1986) is often replaced or at least completed by commercially available membrane degassing units (OHTA et al., 2009) . However, the requirements of a robust and simple sampling procedure, high extraction efficiency and the absence of any contamination with atmospheric air remained the same. While this is relatively simple to achieve in standard situations, i.e tapped wells or open boreholes with submersible pumps it becomes more difficult in exotic environments (STURCHIO et al., 2004).

Similarly, the noble gas purification facilities had continuously to be adjusted to the rapid development of new detection methods (RIEDMANN, 2011). Currently 5-10 µl of Kr are required for a ^{81,85}Kr ATTA analysis (JIANG et al., in press), a similar amount than for ^{85}Kr LLC measurements (ALTHAUS et al., 2009). Conventionally, gaschromatographic methods are at least part of each large volume noble gas purification facility (LOOSLI and PURTSCHERT, 2005; MOMOSHIMA et al., 2010). This may be combined or completed by cryogenic distillation (YOKOCHI et al., 2008). In the future, with further decreasing sample volumes, noble gas purification by getter techniques will become more important. However, the parallel purification and detection of Kr and Ar isotopes from the same sample requires an accordingly adapted procedure (LOOSLI et al., 1986; RIEDMANN, 2011).

At the Physics institute of University of Bern, the detection of radio noble gases by LLC has a long tradition. In the talk an overview is given about sampling and purification strategies developed and used here over the last 20 years. The lesson learned should be a starting point for the discussion of future perspectives.

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