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## Using Sulphur-34 Analyses in Applied Hydrogeology. Examples from the Northern Calcareous Alps, Austria

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Within the structurally and hydrogeologically complex Northern Calcareous Alps, Austria, sulphate-bearing Permian-Triassic evaporite deposits of the Alpine Haselgebirge, Reichenhall and Raibl Formations are common and characterised by distinct  $\delta^{34}\text{S}$  values of  $\sim+11\%$ ,  $\sim+25\%$ , and  $\sim+16\%$  VCDT, respectively (Spötl, 1988; Spötl & Pak, 1996; Göttinger et al., 2001).

Being largely unaffected by low-temperature dissolution processes, these sulphur stable isotopic signatures are inherited into the sulphate found in the groundwaters interacting with these highly soluble rocks thus providing a unique tool to trace the sulphate source(s) of the subsurface waters.

**Table 1** shows some of the  $\delta^{34}\text{S}$  values obtained from sulphate-bearing groundwater during projects carried out in the regions of Brixlegg and Innsbruck, Tyrol, Austria.

Sampling Site	Region	$\delta^{34}\text{S}$ (‰ VCDT)	SO <sub>4</sub> (mg/l)	Sulphate Source
WS1	Innsbruck	+24,0	420	Reichenhall Fm.
MBL	Innsbruck	+21,6	230	Mainly Reichenhall Fm.
VEQ	Innsbruck	+12,8	26	Raibl Fm.
AQV	Brixlegg	+23,3	860	Reichenhall Fm.
GB1 - 4	Brixlegg	+16,8 – +21,3	130 - 330	Mixed
AHBM	Brixlegg	+15,3	660	Raibl Fm.

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For the Innsbruck project, which included estimating the extent and geology of the aquifer of large natural springs (flow-rate 150 l/s),  $\delta^{34}\text{S}$  analyses helped along with hydrochemistry,  $\delta^{18}\text{O}$  and  $^3\text{H}$  analyses, in verifying the source of the sulphate rich waters. In this study,  $\delta^{34}\text{S}$  analyses of the groundwater confirmed the existence of the Reichenhall Fm. in the subsurface of the catchment area, were as geological mapping only suggests the presence of Raibl Fm.

In Brixlegg, where a railway tunnel was constructed close to and penetrating various important mineral water (spa) aquifers,  $\delta^{34}\text{S}$  analyses aided in confirming the extent and nature of these aquifers.

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