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A hydrogeological map of the Calcareous Alps between the rivers Enns and Ybbs

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The study area is situated in the northern Calcareous Alps at the border between Upper and Lower Austria. It is dominated by Upper Triassic dolomites and limestones (Hauptdolomit and Opponitz formation) which serve as large-scale karst water reservoirs (TRAINDL, 1982). Sandstones and shales of the Lunz formation mostly build the impermeable base of these reservoirs. Tectonically, the units belong to the Frankenfels-Lunz nappe system, a sequence of large folds inclined towards NW and intersected by strike-slip faults. These faults are accompanied by cataclasites and karst structures which constitute zones of preferred groundwater flow (DECKER et al., 1998). In the areas between fault zones, dolomites exhibit regular, narrow joint and fracture patterns which give rise to high storage and retention capacities as well as good filtering of groundwater. Finally, Quaternary valley fills represent additional important aquifers in the study area.

Since 1992 the area has been investigated hydrogeologically (HEINRICH et al., 1995 and 2000; PFLEIDERER et al., 1999 ad 2004). Springs with strong groundwater discharge ($>$ 10 l/s) even during dry periods are mostly associated with catchment areas made of Upper Triassic dolomites and limestones. For springs in dolomites, this is due to a moderate karstification and a dense pattern of fissures resulting in large storage volumes and good retention capacity. For springs in limestones, on the other hand, large catchment areas of homogeneous lithology and tectonic structure guarantee sizeable groundwater discharge during dry periods.

Groundwater chemistry was studied using samples collected during dry periods and analysed for major ions (Ca, Mg, Na, K, SO_4, HCO_3, Cl, F, NO_3) and trace elements (H_2SiO_3, Cd, Cr, Cu, Pb, Zn, Al, Fe, Sr, Mn, Li). The map shows how hydrofa-

cies correlates directly with lithofacies. Catchment areas dominated by Upper Triassic dolomites yield water with equal Ca- and Mg-concentrations ($\sim$ 2 meq/l) and low Na-, K- and Cl-content ($\sim$ 0.01 meq/l) whereas groundwater circulating through Middle Triassic and Jurassic limestones show lower values of Mg ($\sim$ 0.4 meq/l) and a wider range of Na-, K- and Cl-values($\sim$ 0.01 - 0.1 meq/l). Groundwater with high levels of sulphate ($>$ 10 meq/l) occurs in areas with gypsum-bearing strata. Trace elements in groundwater exist in very low concentrations ($\sim$ 5 - 10 μeq/l), occasionally elevated in sandstones and shales of the Lunz formation.

The map includes the locations of water supply facilities inventoried by provincial governments, and indicates the size of major springs and water wells.

At the scale of 1:50.000, the map represents the work of several multi-disciplinary projects and respects all relevant data on the hydrogeology, isotope hydrology, hydrochemistry, rock and soil chemistry, geology, gephysics and tectonics of the study area. The map layout follows the standards set by the Austrian Standards Institute as well as recommendations by STRUCKMEIER & MARGAT (1995). The hydrogeological classification of geological units results from the integration of field observations, laboratory analyses and information from governmental inventories. The class of porous aquifers consists of coarse grained Quaternary soft sediments which are fed by groundwater flowing from surrounding hard rocks and are used for water supply. The class of karstified aquifers comprises limestones of Middle and Upper Triassic and Middle Jurassic age. Less karstified aquifers consist of Upper Jurassic marly limestones and various siliceous limestones. The Hauptdolomit formation which hydrogeologically represents a transition between karst and fissured rock forms a further class of aquifers. Aquitards comprise fine-grained Quaternary sediments, Neocomian marls, Upper Triassic sandstones and shales and Permo-Scythian claystone.

Orographic borders between catchment areas are indicated on the map although especially in karstified regions they do not always coincide with phreatic water divides. Assumed groundwater flow across orographic watersheds is marked wherever plausible based on water budget estimation, oxygen isotope analyses, hydrochemical or tectonic evidence. Further investigation, e.g. tracer tests, would be required to ascertain these assumptions.

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