

First preliminary map of deep CO₂ degassing in Alpine region

MARCO DONNINI^{1,2}, FRANCESCO FRONDI^{1*}, CARLO CARDELLINI¹, STEFANO CALIRO³, GIOVANNI CHIODINI³, IVAN MARCHESINI² AND FAUSTO GUZZETTI²

¹ Università degli Studi di Perugia. Dipartimento di Scienze della Terra. Perugia, Italy (*correspondence: frondini@unipg.it)

² Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica. Perugia, Italy

³ Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano. Perugia, Italy

Processes of CO₂ degassing affect almost all tectonically active areas and metamorphic environments. Here we show the first preliminary map of deep-CO₂ degassing of the Alps based on more than 1000 chemical analyses of springs (both data from literature and new data). Using PHREEQC, for each point we estimated the total dissolved inorganic carbon (TDIC) and through an isotopic and mass balance approach we estimated the values of C_{carb}, carbon deriving from carbonate dissolution, and C_{inf}, the sum between atmospheric CO₂ dissolved by rainwater and biogenic CO₂. C_{deep}, carbon deriving from deep degassing, has been computed considering that [1]: TDIC = C_{carb} + C_{inf} + C_{deep}. C_{carb}, given by Ca+Mg-SO₄, has been estimated for springs fed by carbonate aquifers. The flux of deep CO₂ associated to each spring discharge is given by C_{deep} X Q/A, (Q: flow rate, A: recharge area), or by C_{deep} X IE, (IE: effective infiltration, IE=Q/A). IE for each basin have been estimated using a water balance model [2]. Finally we prepared the CO₂ degassing map using GSLIB [3]. The results show that CO₂ production of Alps is 3 times lower than CO₂ production in Central Italy [4], but locally (like in Engadine, Lucomagno Pass, Valtellina etc..) CO₂ fluxes are one order of magnitude higher than the baseline of geothermal regions [5]. The highest deep-CO₂ degassing areas are located along the more important alpine tectonic structures and in the basins external to the alpine chain. In these areas more detailed investigations should be performed in order to obtain a complete evaluation of the extent and distribution of the CO₂ anomalies of the Alps.

[1] Chiodini *et al.* (2000) *Journal of Geophysical Research* **105**. [2] Rossi *et al.* (2013) *XIV GRASS e GFOSS meeting*. [3] Deutsch and Journel (1988) *Oxford Univ. Press* [4] Chiodini *et al.* (2004) *Geophysical Research Letters* **31**. [5] Kerrick *et al.* (1995) *Chemical Geology* **121**.

Alpine weathering and carbon cycle

MARCO DONNINI^{1,4*}, JEAN-LUC PROBST^{2,3}, ANNE PROBST^{2,3}, FRANCESCO FRONDI¹, IVAN MARCHESINI⁴ AND FAUSTO GUZZETTI⁴

¹ Università degli Studi di Perugia. Dipartimento di Scienze della Terra. Perugia, Italy (*correspondence: marco.donnini@tiscali.it)

² University of Toulouse ; INPT, UPS ; Laboratoire Ecologie Fonctionnelle et Environnement (EcoLab), ENSAT, Castanet Tolosan, France

³ Centre National de la Recherche Scientifique (CNRS), EcoLab, ENSAT Castanet Tolosan, France

⁴ Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica, Perugia, Italy

On geological time-scales the fluxes from atmosphere to solid Earth depend on weathering of silicates and carbonates, biogenic precipitation and removal of CaCO₃ in the oceans and volcanic gases – seawater interactions. Here we estimate the atmospheric CO₂ uptake by weathering in the Alps, using the dissolved loads of 33 Alpine rivers sampled during dry and flood seasons. The dissolved load of streams originates from atmospheric input, pollution, evaporite dissolution, and weathering of carbonate and silicate rocks. We applied the MEGA (Major Element Geochemical Approach) geochemical code [1, 2] to the chemical compositions of the selected rivers in order to quantify the atmospheric CO₂ consumed by weathering. The steps were: (1) subtraction of the rain contribution, (2) the remaining (Na+K) comes from silicate weathering. The average molar ratio $R_{sil} = (Na+K)/(Ca+Mg)$ was estimated for each basin following well known lithological classification [2, 3], (3) lastly we estimated the (Ca+Mg) originating from carbonate weathering. Depending on time-scales we considered different equations for the quantification of the atmospheric CO₂ consumed by weathering [5]. The results show the net predominance of carbonate weathering on fixing atmospheric CO₂ and that, considering different time scales, there is about one order of magnitude of difference on the atmospheric CO₂ fixed by weathering.

[1] Amiotte-Suchet (1995) *Sci. Géol. Mém. Strasbourg* **97**. [2] Amiotte-Suchet and Probst (1996) *Sci. Géologiques Bull. Strasbourg* **49**, 101–126. [3] Meybeck (1996) *Bulletin De La Société Géologique* **39**, 3–77. [4] Meybeck (1987) *Am. J. Sci* **287**, 401–428. [5] Huh (2010) *Society of London, Special Publications* **342**.