Carbon dioxide emissions from high altitude lakes in relation with their geochemistry

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Emission of carbon dioxide (CO_2) from natural water ecosystems to the atmosphere can significantly contribute to climate change. The cycle of inorganic carbon in high altitude lakes and the influence of their geochemistry on it have been barely investigated. This work presents an integrated study conducted in twenty high altitude pristine lakes from the Western Pyrenees. These small lakes show similar physical properties (i.e. size, depth) but differ from their catchment characteristics and geological background (i.e. granitic vs sedimentary rocks). Subsurface (~0.5 m depth) water samples were collected in June/October 2017/2018 to investigate possible spatial and seasonal variations in the water hydrological and geochemical characteristics (temperature, dissolved oxygen, silicates, TOC, DIC, total alkalinity, anions, major and trace cations). The determination of both DIC and total alkalinity allowed us to calculate the other two parameters to characterize the carbonate system: pH and fugacity of CO_2 (fCO_2). Comparison between filtered (<0.45µm) and unfiltered samples highlighted significant differences for trace elements such as Al, Fe and Ti, probably bounded to organic matter and/or suspended inorganic solids. While some of the trace metals were not detected in most of the samples, Sb (10-78 ng/L), As (115-8186 ng/L), Se (12-89 ng/L) and Hg (115-8186 pg/L) as well as SO_4^{2-} (0.3-7.6 mg/L) showed strong seasonal variations mainly related to geographical patterns (watershed, orientation). This trend is confirmed by the high correlation found among elements of lithologenic origin (Sr, Ba, Ca, Mg). fCO_2 (526-3188 µatm) was well above the global fugacity of CO_2 in air (409 µatm) suggesting that these high altitude lakes emit a considerable amount of CO_2 to the atmosphere. fCO_2 is well correlated with the geological tracers mentioned above as well as altitude. Since these high altitude lakes are pristine areas, it is necessary to monitor these sensitive ecosystems in order to understand how the global anthropogenic pressure can affect their geochemistry as well as their CO_2 emissions.