



## The release of dissolved inorganic carbon (DIC) and CO<sub>2</sub> from coal mine drainages

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### Extended Abstract

Coal utilization contributes to the release of geologically-bound carbon directly through combustion plus indirectly by accelerated weathering of carbonate minerals. Although CO<sub>2</sub> from combustion is instantly added to the modern carbon cycle, sulfuric-acid driven weathering of carbonate minerals tends to release geologically-bound carbon for decades. Coal mine drainage (CMD) commonly contains elevated concentrations of dissolved inorganic carbon (DIC) derived from weathering of carbonate overburden minerals, with corresponding partial pressure of CO<sub>2</sub> ranging from 10 to 1000 times greater than atmospheric equilibrium. Depending on the pH, the release of DIC can be in the form of CO<sub>2</sub>, which degasses to the atmosphere, or as dissolved bicarbonate which is exported downstream. The sulfuric-acid driven weathering of carbonate rocks in coal may have important implications for global carbon cycles because the old carbon is released without the concomitant drawdown of atmospheric carbon as with carbonic-acid driven weathering.

Our work employs the Anton Paar Carbonation Meter to obtain accurate and precise concentrations of CO<sub>2</sub> and DIC in water. These methods are modified from similar methods using the same instrument (Vesper and Edenborn 2012; Vesper et al. 2015). By obtaining data via this method, we avoid the pitfalls from determining CO<sub>2</sub> via back-calculation from either alkalinity or conventional DIC analysis. The back-calculation underestimates CO<sub>2</sub> pressures by excluding waters with low pHs (and hence no alkalinity). Standard methods of DIC analysis do not prevent the loss of CO<sub>2</sub> during analysis and therefore underestimate DIC in high-pCO<sub>2</sub> samples. Our approach allows us to determine the CO<sub>2</sub> concentration in low-pH and high-pCO<sub>2</sub> waters rather than excluding those hard-to-measure samples.

We have collected DIC and CO<sub>2</sub> data from CMD sites in the northern Appalachian Basin, including mines in West Virginia and from both the bituminous and anthracite regions of Pennsylvania (Vesper et al. 2016). The DIC concentrations almost always exceed atmospheric equilibrium values. Based on published and measured data, the release of DIC from individual mine discharges exceeds estimates and reported concentrations for carbonate springs or most terrestrial surface waters. Furthermore, DIC at a given CMD source can be relatively consistent or vary substantially over various time scales. Diurnal cycles, rain events, shifts in recharge, and seasonal changes in precipitation can alter the DIC concentration and flux (Bell 2020; Riddell 2015).

The implications of this work have yet to be fully determined although one study indicates that 140 mines in Pennsylvania have a comparable emission to a

small power plant (Vesper et al. 2016). Given that this is only a subset of the mine discharges in Pennsylvania, this emission is an underestimate of the total flux. Better regional-scale estimates will require more watershed-based spatial data and more precise discharge location information; additional sampling would help constrain possible temporal variations.

**Keywords:** CO<sub>2</sub>, degassing, mine drainage

## References

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