Thermodynamics of the C-H-O fluids: High pressure experiments on dissociation of carbonates and hydrides

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Understanding the chemistry of carbon in deep Earth's interior requires thermodynamic data on the multicomponent C-H-O fluid. Experimental data on such fluids at high temperature and high pressure mantle conditions is quite rare. In this study we use new experimental methods and computations to produce pressure-volume-temperature (P-V-T) equation of state (EoS) data on CO_2 and H_2 fluids to pressures of 100 GPa and very high temperatures.

The thermodynamic properties and P-V-T EoS for CO_2 and H_2 fluids are assessed by combining experimental data on equillibrium conditions for several carbonate and hydride dissociation reactions involving these fluids with P-V-T EoS' of solid phases involved in the given reactions. Experimental P-V-T data on several carbonates and hydrides used in this study was extensively collected from literature and missing P-V-T data was measured using resistively heated and laser heated diamond anvil cell and *in situ* x-ray diffraction. The P-V-T EoS' for the CO_2 and H_2 are thus self consistent with experimental phase equilibrium data and standard thermochemical data. The EoS' are also shown to be consistent with results obtained independently using molecular dynamics calculations [1].

The newly created thermodynamic database was used to calculate high pressure and temperature phase equilibrium in several binary, ternary and multicomponent systems.

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Comparison of ^{228}Ra and microstructure derived ocean mixing rates and chemical fluxes in the Cape Basin

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Diapycnal mixing from below is a critical route by which nutrients and other chemical species are introduced to the sunlit surface ocean. Instantaneous mixing rates can be assessed by shipboard measurements of velocity microstructure in the water column. Radium-228, a daughter of ^{232}Th, has a half life of 5.75 years, and is mixed into the ocean interior from ocean shelves and downwards from the surface by diapycnal mixing. It therefore provides a means to assess the long-term average mixing rates in the oceans. In this study, we compare instantaneous mixing rates from velocity microstructure with long-term rates from ^{228}Ra for waters of the Cape Basin. We use these measured mixing rates to assess the supply of nutrients to the surface ocean in this region, and the temoral variability of this supply.

Twenty five seawater samples were collected from the Cape Basin during the 2010 UK GEOTRACES cruise (GA10E) and analysed for high-precision ^{228}Ra and ^{226}Ra concentrations by MC-ICP-MS. We estimated vertical and horizontal ocean mixing rates from this data using 1D mixing models to derive rates of 0.9 – 2.1 cm^2s^{-1} and 3.8 × 10^7 cm^2s^{-1} respectively. The rates of diapycnal mixing indicate sufficient nutrient supply to drive the productivity in downward organic carbon fluxes of 3.1 – 3.3 mmol C $m^{-2}d^{-1}$ in this region – in close agreement with estimates from other proxies. The long-term averages are compared with instantaneous mixing rate and nutrient supply derived from microstructure measurements from the same cruise to assess the merits of the two approaches and variation in the mixing environment.

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