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The 2005 WMO Research Award

for Young Scientists was conferred on *Dr Xiao Cunde* (China) for his paper entitled "Sea level pressure variability over the southern Indian Ocean inferred from a glaciochemical record in Princess Elisabeth Land, east Antarctica" (published in the Journal of Geophysical Research, Vol. 109, D16101) .

Dr Nedjeljka Zagar (Sweden) received the award for her paper entitled "Assimilation of Equatorial Waves by Line-of-sight Wind Observations" (published in the Journal of Atmospheric Science, no 61, pp 1877-1893).

Perturbation of Hydrochemical Conditions in Natural Microcosms Entombed within Antarctic Ice

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Taylor Valley, one of the McMurdo Dry Valleys located in Southern Victoria Land, Antarctica, is a polar desert with extreme climatic conditions *[Priscu et al, 1998]*. The annual average value for air temperature is -17°C, for precipitation is <10 mm, for potential sublimation is 8 cm and for wind speed is 5 m/s. It is the location of the McMurdo LTER (Long Term Ecological Research) project, partly because of the sensitivity of the ecosystem to small variations in climate *[Doran et al, 2002]*. Life has been documented in a wide range of icy environments *[McKnight et al, 2002; Priscu et al, 1998, 1999; Friedmann et al, 1993],* including near-surface, intraglacial habitats in cryoconite holes *[Wharton et al, 1985]*. Water may be contained within cryoconite holes for several months each year, and the holes are colonised largely by coccoid and filamentous cynanobacteria (Oscillatoriales), with some chlorophytes, diatoms, rotifers and tardigrades *[Mueller et al, 2001]*.

Cryoconite holes initially form as a consequence of solar heating of sediment and dark-coloured algae resident on the glacier surface. The hole depth reaches an equilibrium value based on the heat supplied by solar radiation and heat lost to the colder ice *[McIntyre, 1984]*. The entire hole freezes solid in winter. The hole reforms in summer when solar radiation transmits through the ice and heats the dark sediment and organic matter at depth. Once formed, it is unlikely that the holes are open to the atmosphere on an annual basis, given the ice lid thickness (30-40 cm) and the rate of sublimation *[~8cm/yr; Fountain et al, 1998]*. Rather, the holes open during warm spells that reoccur on decadal timescales *[Doran et al, 2002]*. Other hydrological and biological features of cryoconite holes in Taylor Valley are described eleswhere *[Fountain et al, 2004; Porazinska et al, 2004]*.

Solute in cryoconite water is obtained from icemelt, and the dissolution of aerosol and debris, but is excluded from the freezing lid. Hence, solute accumulates in the hole over time *(Figure 1)*. Atmospheric gases (e.g. N_2, O_2 and CO_2) are acquired from bubbles in the ice during the downward melting of the hole, and subsequently are either involved in biogeochemical reactions within the hole and/or may contribute to the gases that accumulate in the head space above the water column. Some gas and particulate exchange may occur with the atmosphere during the melt in of debris through the ice lens, and the melt out of debris and gas bubbles. These processes have been well documented for lake ice cover *[Adams and Priscu, 1998]*. Further, there is some connectivity between about 50% of the holes *[Fountain et al, 2004]*. Hence, gaseous exchange with the atmosphere is very low in the unconnected holes, and is at least impeded in the connected holes.

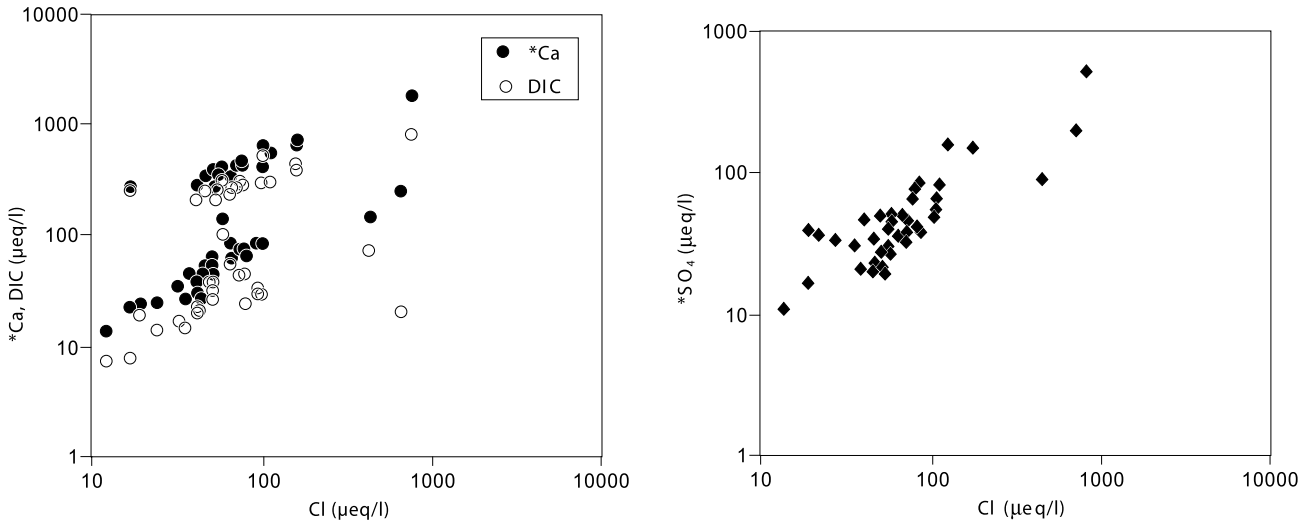

Figure 1. Scatterplot of non sea-salt calcium (*Ca), DIC (dissolved inorganic carbon) and non sea-salt sulphate ($*SO_4^{-2}$) versus chloride in waters within cyoconite holes on glaciers in Taylor Valley, Antarctica.

The photoautotrophs and heterotrophs which grow within the closed cryoconites holes perturb the poorly buffered water chemistry, yet maintain the potential for photosynthesis. Microbial excretion and decomposition of organic matter produces DOC (dissolved organic carbon): DIC (dissolved inorganic carbon) ratios of ~1:2. Much of the dissolved N pool (80-100%) exists as dissolved organic nitrogen (DON). The DON:DOC ratio is ~1:11 (mol/mol), typical of organic particulate material at the Earth's surface. The combination of photoautotrophy, heterotrophy and weak chemical buffering within these microcosms promotes values of pH, pCO_2 (*Figure 2*), O_2 saturation and % total dissolved nitrogen (TDN) as DON that reach 10.99, $10^{-7.6}$ atms, 160% and 100% respectively, which are a unique combination among the surface waters on Earth (Tranter et al, 2004). These ice-sealed cryoconite holes could be important analogues of refugia on Snowball Earth and other icy planets.

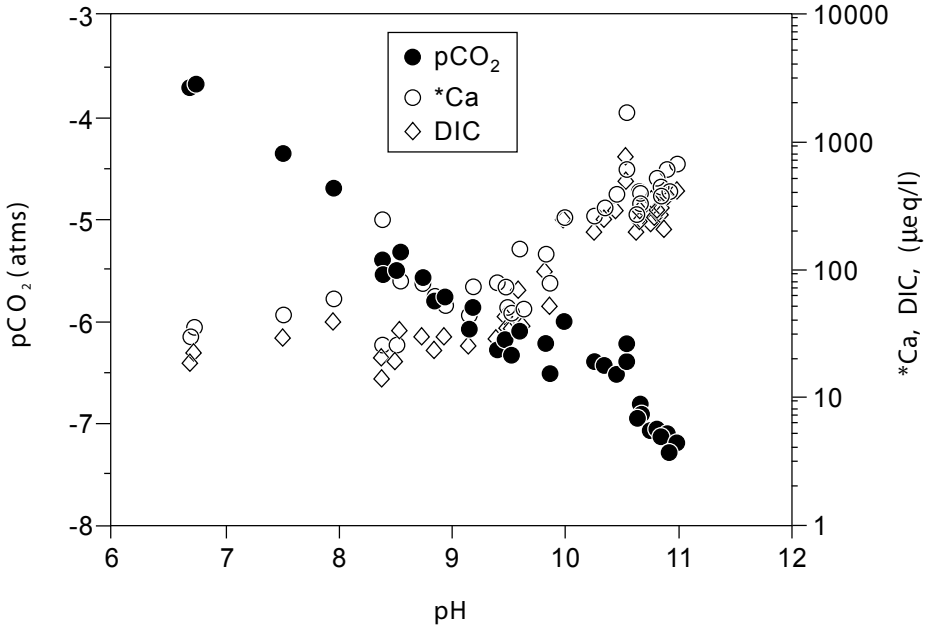

Figure 2. Scatterplot of the partical pressure of carbon dioxide (pCO_2), non sea-salt calcium (*Ca) and dissolved inorganic carbon (DIC) versus pH in waters within cryoconite holes on glaciers in Taylor Valley, Antarctica

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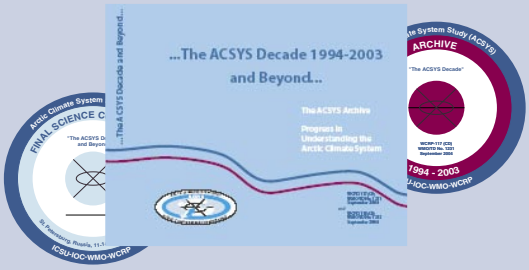

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