identification of new gold resources. However, fluid inclusions in many gold deposits record evidence of coexisting liquid and vapour (Fig. 1c; similar to water boiling). If the flash vaporization concept is correct, much of this work will have been in vain, because the fluid inclusions cannot have formed during the flash vaporization stage when the gold was actually deposited in the silica-gel material. Instead, the fluid inclusions must have been trapped at some unknown time after gold deposition when the silica-gel formed crystalline quartz. At best, the inclusions may only record the last stages of fluid pressure recovery, after a flash vaporization event.

The emerging links between earthquakes and gold precipitation help to explain the formation of gold deposits that formed in ancient faults, which supply nearly half the world's mined gold. This includes the famous and rich gold mines of the Abitibi belt, eastern Canada, and the Kalgoorlie area, western Australia, that both formed more than 2.5 billion years ago. This growing body of research shows the importance of rough, jagged fault zones with extensively fractured adjacent rock, rather than smooth fault zones with no steps to induce water-pressure changes during earthquakes. These concepts are useful at the mine scale, when resource geologists need to predict the three-dimensional geometry of the ore deposit to be mined.

Weatherley and Henley[1] suggest that gold may be deposited almost instantaneously during earthquakes. They draw attention to processes that occur on a timescale of seconds — in a branch of science that traditionally thinks in terms of millions of years. ❐

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OCEANOGRAPHY

Rise from below

Most of the world's deep oceans are filled by cold and relatively fresh water originating from the Southern Ocean. Antarctic Bottom Water, as it is called, forms when dense waters that pool along the Antarctic shelf spill down into the deep ocean. This water mass, which comes from at least four specific coastal sites, eventually flows north to fill the ocean abyss. Although cold by most standards, a limited array of measurements has suggested that Antarctic Bottom Water has become warmer and less salty since the 1950s. The data remain sketchy, but the possibility of such trends is a cause for concern, given the large amount of heat and carbon stored in the ocean abyss.

To better quantify changes in Antarctic Bottom Water properties, Sarah Purkey and Gregory Johnson of the University of Washington, Seattle, compiled publically available measurements of temperature and salinity in the Southern Ocean, collected between 1980 and 2012 (*J. Clim*. http://doi.org/kr6; 2013). Focusing on the area south of 30° S, they reconstructed changes in the characteristics and volume of Antarctic Bottom Water over this period.

They identified a clear trend towards less salty water in the Pacific and Indian sectors of the Southern Ocean, equivalent to an uptake of about 70 Gt yr^{-1} of freshwater. This is roughly half the estimated freshwater input from ice melt in West Antarctica between 1992 and 2006. Moreover, the greatest drop in salinity was seen closest to the formation sites, with little to no freshening seen in the older, more distant waters. This implies a recent increase in freshwater uptake. A small but significant warming was detected in the same water mass.

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As well as the temperature and salinity changes, Purkey and Johnson documented a decrease in the volume of Antarctic Bottom Water formed since the 1980s. Declining production can explain many of the hydrographic changes they observed in deep ocean basins not adjacent to Antarctica; for example, increasing salinity in water masses below a depth of 2,000 metres.

Intriguingly, although most efforts to measure sea-level rise focus on changes in upper ocean heat content and meltwater from terrestrial glaciers and ice sheets, these changes in deep water properties and geometry should also have an effect on sea level in the Southern Ocean south of 30°. Purkey and Johnson estimated that thermal expansion and changes in the distribution of bottom water resulted in a local mean sea-level rise of about a half a millimetre per year, not insignificant compared to the global mean of three millimetres per year.

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