The results presented in Fig. 4, showing summed UV absorbance plotted against surface salinity, with the low absorbance associated with open ocean salinities, suggest that in autumn 1977 *in situ* marine biological activity was at most a minor contributor of the detected organic material. When the mid-line of the data envelope of Fig. 4 is extrapolated back to a salinity of 0‰, it yields a summed UV absorbance of 33 units, which is barely one-half the summed absorbance determined for a sample taken during November 1977 from the major river flowing into Galway Bay. This discrepancy suggests that some alteration of the yellow pigment may be occurring when the freshwater in which it is dissolved begins to mix with saltwater[9].

It should be noted that the concentration of chlorophyll *a*, as determined for 38 of these stations, was typically low, with the highest concentration encountered being 1.88 mg m^{-3}.

Thus, if a satellite equipped with a multi-spectral scanner capable of measuring seawater colour had been passing over the coastal waters west of Ireland during the autumn of 1977, it would have been possible, using 'sea-truth' data of the type reported here, to determine with some degree of accuracy the surface distribution of salinity and dissolved organic matter.

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Changing hydrothermal activity in the Atlantis II Deep geothermal system

THE Atlantis II Deep is a pool of hot saline brine at the bottom of the central rift in the Red Sea (Fig. 1). Since its discovery in 1965 (ref. 1) it has undergone repeated detailed investigations[2,3]. A permanent increase of temperature has been reported by many workers[4–8] and was interpreted as the result of the injection of hot brine to the system. The temperature of the inflowing brine was estimated to range between 110 and 210 °C (refs 6, 8). We have reinvestigated (after five years) the Atlantis II Deep on board RV Sonne. We report here the results of temperature measurements which were carried out in November 1977.

We used the same instruments as for our previous temperature measurements[7,8]: first, a platinum high resistance thermoprobe as a semicontinuously recording instrument (Bathysonde T 83(3); and, second, deep-sea reversal thermometers. The reversal thermometers have been calibrated and their absolute accuracy is estimated to be ±0.1 °C over the past 5 yr. The bathysonde thermoprobe gave readings of the temperature which were 0.1–0.4 °C higher than those of the deep-sea reversal thermometers at the same position. We, therefore, calibrated all temperatures in Table 1 according to the deep-sea reversal thermometer readings.

The temperature structure of the system is essentially the same as described previously (see Fig. 2). However, temperatures within the two convection layers have changed. The convective mixing within the lower brine brought about a marked increase in the temperature in remote basins of the pool (Table 1). In the North Basin the temperatures are still lower than in the South-west Basin, which indicates that the convective exchange of brine is continuing.

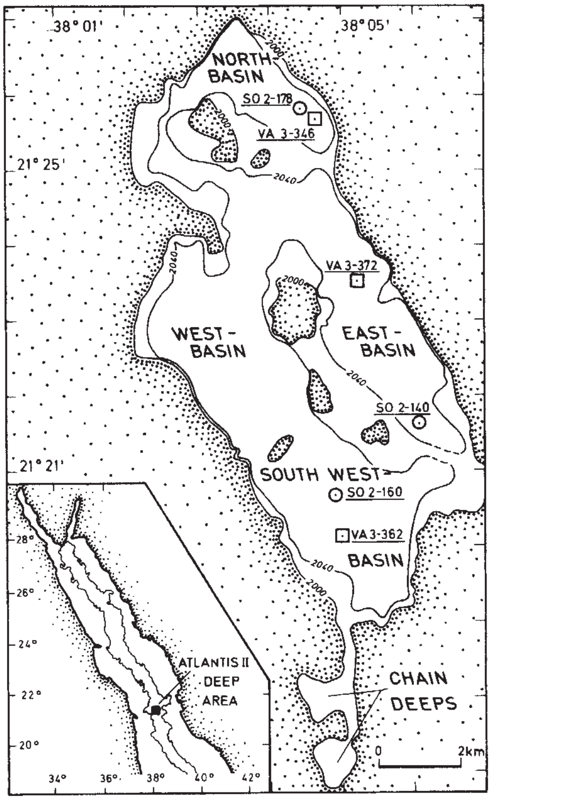

Fig. 1 Bathymetry of the Atlantis II Deep brine pool. The hydrographic stations which are discussed in this paper are indicated. The 2,000 m isobath is the approximate contour of the top of the mixing layer (ML in Fig. 2) and the 2,040 m isobath contours the top of the lower convection layer.

A significant decrease of the temperature by about 0.7 °C since 1972 can be seen in the upper convection layer (see Table 1). A change of the temperature in this layer, however, is not representative of the whole system and may be caused by mixing from above and advective processes.

The temperature development of the lower convection layer in the South-west Basin, that is, the discharge area of the Atlantis II Deep brine pool should reflect changes in the hydrothermal activity. Table 1 and Fig. 2 show the temperatures to have risen there, again since 1972, by 1.71 °C in the lower convection layer. This increase of temperature is equal to a mean heating rate of only 0.29 °C per year. When compared with the value in 1971–72 of 0.75 °C per year it becomes obvious that the heating rate has slowed down considerably.

An accompanying phenomenon is the change of the temperature structure of the high temperature zone immediately below the interface of the upper and lower convection layer (see insets in Fig. 2, and Table 1). The temperature peaks were previously clearly detectable in this zone. The differences of mean and maximum temperatures in 1971 and 1972 were 0.58 °C and 0.26 °C, respectively. This characteristic structure is at present only detectable with difficulty by the temperature probe; that is no rising hot brine is presently accumulating below the interface. We regard both the decrease of the heating

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Table 1 Temperatures in various depths of the upper- and lower-convection layer (UCL and LCL, respectively) as well as in the high temperature zone (HTZ) below the interface LCL/UCL

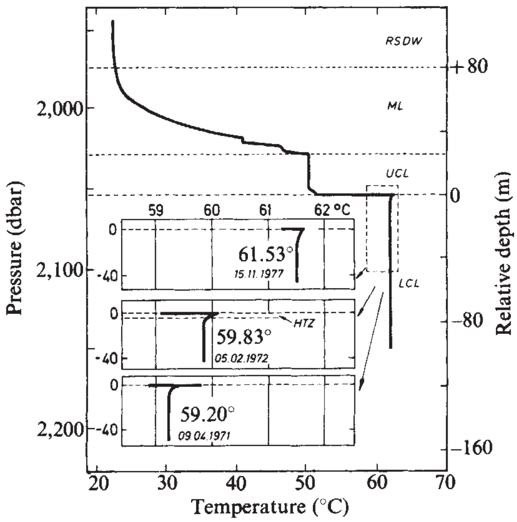
Zone (see Fig. 2)	Depth (dbar)	South-west Basin 1977[1]	South-west Basin 1972[2]	East Basin 1977[3]	East Basin 1972[4]	North Basin 1977[5]	North Basin 1972[6]
	+20	49.95	50.62	49.90	50.62	49.77	50.48
	+15	49.95	50.52	49.90	50.60	49.79	50.68
UCL	+10	49.91	50.76	49.92	50.64	49.79	51.26
	+5	49.97	51.02	49.90	51.30	49.79	51.24
	+2	50.93	51.52	50.83	51.78	50.37	51.64
HTZ		61.60	60.08	61.45	59.82	60.56	58.44
	−2	61.60	59.98	61.43	59.82	60.54	58.44
	−5	61.54	59.86	61.41	59.84	60.02	58.50
	−10	61.54	59.86	61.47	59.84	59.98	58.26
LCL	−20	61.52	59.74	61.47	59.76	59.51	57.30
	−30	61.52	59.84	61.45	59.74	59.31	56.90
	−100	61.52	59.80	—	—	55.0+	55.60
	−150	—	—	—	—	—	53.72
Mean LCL value		61.53	59.82	61.45	59.79	—	—

Depth is given relative to this interface (see Fig. 2). In the upper line of the HTZ lines the maximum temperatures are indicated. (Bathysonde values corrected after reversing thermometer readings.)
[1] Station SO 2-160 BS+H: 21°20,68′ N 38°04,92′
[2] Station VA3-362 BS+H: 21°20,14′ N 38°05,01′
[3] Station SO 2-140 BS+H: 21°21,63′ N 38°06,10′
[4] Station VA3-372 BS+H: 21°25,51′ N 38°05,24′
[5] Station SO 2-178 BS+H: 21°25,81′ N 38°04,44′
[6] Station VA 3-346 BS+H: 21°25,79′ N 38°04,66′

rate and the lack of the high temperature zone as evidence of a considerable change in the hydrothermal activity.

There are two possible causes: first, the intensity of discharge has slowed down or second, the temperature of the inflowing brine has dropped considerably compared to 1971 and 1972. It is, at present, not possible to decide between these possibilities.

Fig. 2 Temperature–depth profile of the Atlantis II Deep brines which was recorded in November 1977 at station SO2-160 BS+H. The insets give details of the high temperature zone just below the interface of the upper convection layer (UCL) and the lower convection layer (LCL). The temperature peaks are caused by accumulating hot brine which rise as plumes due to their slightly lower density. The fading of these temperature peaks with time is the best indication of the decrease of the hydrothermal activity.



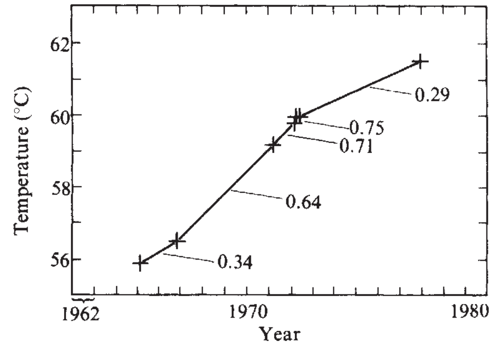


Fig. 3 Mean heating rates of the Atlantis II Deep lower convection layer. The heating rates culminated in 1971–72 and slowed down during the past 5 yr.

As shown in Fig. 3, the period since the discovery of the Atlantis II Deep in 1965 represents a nearly complete cycle of increasing and decreasing hydrothermal activity. According to earlier results[10] this cycle is accompanied by changing conditions within the brine and with changes in the amount and composition of the material precipitating from the brines. Taking as a rough estimate a sedimentation rate of 1 m kyr^{-1} (ref. 11), during the last cycle, a sediment layer of more than 10 mm should have formed since 1965. Due to the very soft or nearly fluid sediment, this uppermost layer cannot be sampled. Sediment cores from the Atlantis II Deep, however, show that this scale of microlayering (mm to cm) which represents the continuously changing supply of metal sulphides, iron-hydroxides and silicates, is characteristic for the younger sediment sections of the Atlantis II Deep.

Frequently changing hydrothermal activities are characteristic of continental geothermal areas. The activity of geysers, for example, depends on surface parameters such as rainfall, morphology, and sub-bottom drainage[11,12]. The triggering mechanism for pulsation in the Atlantis II Deep is not known; it may be due to tectonic movements along the steep faults of the basin, or to the self sealing of discharge vents. Examples of anhydrite coatings in vents from the floor of the South-west Basin have already been described[3].

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