Calibrating basin models of the rapidly buried, microbially active, Shimokita Coalbeds to model a deep biosphere over deep geological time

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The biosphere within the Shimokita coalbeds is currently the deepest evidence of microbial life encountered by scientific ocean drilling. Within the currently drilled interval down to 2466 m below seafloor, the coalbeds constitute a significant oasis amongst otherwise TOC-poor strata. Using thermal maturity parameters sensitive to early diagenetic as opposed to petroleum generating processes, we calibrated a basin model to obtain palaeotemperatures. Palaeotemperatures were then used to model formation-averaged inventories of indigenous cells. This was done as a material balance in which the proportion of carbon present in living cells varied due to temperature dependent cell-building, -repairing and -damaging reactions. It was found that observed indiginoeus cell concentrations could be best explained by models that took account of a transition from a warm active-rift environment to the present-day cool aseismic environment, and with coal units Neogene in age or younger. Models not meeting these criteria overpredicted cell concentrations in shallower TOC-poor formations (see Fig 1.). Interogration of the model found overprediction was caused by lengthened “nursery stages”, in which the deep biosphere was artifically nurtured at mild temperatures prior to deeper burial. This Basin Modelling demonstrates that present day temperature is not a good indicator of the deep-biosphere vibrancy. Instead, energy provision and time spent in optimal growth conditions are essential aspects.

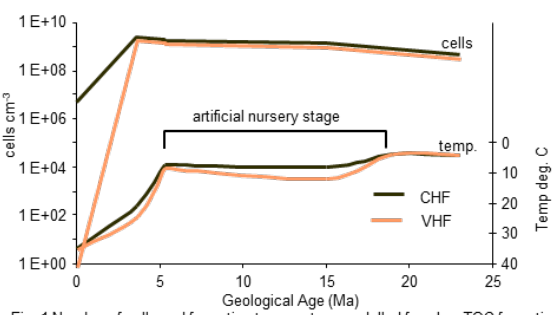

Fig. 1 Number of cells and formation temperature modelled for a low-TOC formation . Data at top of graph illustrates number of cells, data at base formation temperature. CHF: constant heat flow model. VHF: variable heat flow model incorporating a tectonic history.