MODELLING FOR RESOURCES

Transport and Accumulation of Hydrocarbons in Sedimentary Basins

The topographic changes caused by different types of tectonic mechanisms often create a gravity-driven groundwater flow system. The gravity induced flow is the primary mechanism for the transport and accumulation of hydrocarbons in sedimentary basins. Most petroleum deposits originate in fine-grain sediments through the thermal maturation of organic matter into hydrocarbons. A sedimentary basin also transports thermal energy by conduction, dispersion and convection through its layers because of the heated continental crust at its base. It is therefore essential to understand the fluid pressure and temperature history of sediments in the basin for estimating (a) the time of petroleum migration from source rocks to reservoirs and (b) the temperature of petroleum formation. A hydrothermal fluid model for predicting fluid flow and heat transfer in a compacting sedimentary basin is under development at C-MMACS in collaboration with the National Geophysical Research Institute (NGRI), Hyderabad. It is assumed that the groundwater table configuration remains in a similar form for long periods of geologic times. A software was written to solve the coupled set of conservation equations to represent the momentum and energy transport, taking into account the consolidation of sediments. The present version of software solves the problem in two-dimensions using non-orthogonal co-ordinates with appropriate boundary conditions. The software has been validated by comparison with published results for one basin. The software can also be used to study the effect of water table heights on the hydraulic head. *(R N Singh*, M I James, A Manglik*, * NGRI)*

Coal Related Modelling Problems

C-MMACS and the Central Fuel Research Institute (CFRI), Dhanbad have started working on several joint exercises related to Indian coal fields. In one exercise, the basic washability data for selected coal fields obtained by CFRI are being analysed to determine as to how ash content varies with size and density fractions. Another exercise aims at using optical scanning methods to transform existing data on coal fields into computer readable data in standardised formats. A related study examined suitability of several available techniques of interpolation in estimating sulfur content in a coal field in Central India to obtain environmental impact assessment. In yet another exercise, it is proposed to model the processes of coke formation from coal, starting with stack burning. *(K Narasimhan*, S G Tumuluri*, R Dasgupta*, A K Mukherjee*, A Chowdhury*, J Roy*, N K Indira, P S Swathi, M K Sharada, R P Thangavelu, M S Phanikumar, K S Yajnik, * CFRI)*

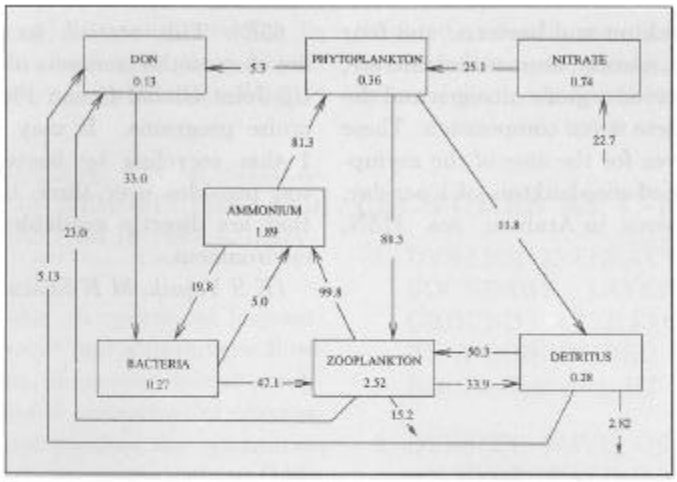

Figure 1: Annual averages of concentrations and fluxes (in millimol N /cu m and millimol N/cu m/year) in a marine ecosystem model. The simulation was carried out for climatological conditions at 15N, 65E.

Modelling of Marine Productivity

The available fish catch depends on the first step in the food web in which phytoplankton grows by incorporating inorganic carbon into organic compounds through the process of photosynthesis. The scale of production of phytoplankton, called primary production, determines the food resources available for higher trophic states. Primary production also plays an important role in the global carbon cycle. The biological pump transforms considerable amount of inorganic carbon to organic carbon in the euphotic zone and transports it to the deep ocean as organic matter. Furthermore, biological processes in the surface layer also influence the net transport of heat by the ocean. A study has been in progress under a project supported by the Department of Ocean Development (DOD) to develop a model that incorporates basic biochemical processes governing primary production in tropical marine environment. Its focus is on dynamical system models of marine ecosystems for the Indian Ocean. Initially, dynamics of a 3-component model of marine ecosystem was studied using phase plane analysis (C-MMACS Annual Report 1992-93). During the present reporting year, a 7-component model of marine ecosystem in the mixed layer was used for simulations for selected Arabian sea stations. These simulations were carried out for climatological variation of solar radiation, mixed layer depth and surface wind stress. Two parameters affecting nutrient supply, namely, subsurface nitrate concentration and diffusion parameter, were varied. In addition, three ecosystem parameters, namely, asymptotic grazing rate of zooplankton and detritus sinking rate were also varied. Annual averages of each component as well as fluxes were obtained to give a quantitative picture of the sensitivity of the ecosystem from the climatological point of view. The system is found to be most sensitive to asymptotic grazing rate and subsurface nitrate concentration. Figure 1 shows typical results in the form of a block diagram giving annual averages of concentrations of three biotic components, namely, phyto-

plankton, zooplankton and bacteria, and four forms of nitrogen, namely, ammonium, nitrate, detritus and dissolved organic nitrogen and the fluxes between these seven components. These quantities are given for the case of the asymptotic grazing rate of zooplankton, of 1 per day, at one of the stations in Arabian sea (15N, 65E). This station has been chosen as it lies close to the transects of the Indian and the US Joint Global Ocean Flux Study (JGOFS) cruise programs. It may be seen from Fig. 1 that recycling by bacteria and zooplankton provides over three times the nutrients that are directly available from the physical environment.

(K S Yajnik, M K Sharada)