HYDROSTATIC MODELS OF MOLECULAR CLOUDS: COMPARISON OF EQUILIBRIUM AND TIME DEPENDENT CHEMISTRY

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The chemical evolution of gas and dust flowing in a molecular cloud from the outer layers to the centre according to a circulation model is studied by calculating the chemical rate equations and the heavy element depletion time-dependently. The cloud structure and the circulation velocity are discussed in paper I (Boland and De Jong, 1984, Astron. Astrophys. 134, 87). We assumed that the circulating matter is in pressure equilibrium with the surrounding gas at all depths into the cloud. In the outer parts of the cloud ($A_V \leqq 2$) the gas is almost in chemical equilibrium because the chemical timescales are short compared to the circulation timescale. In the dense cloud cores the time required to convert C, N and O into molecular form becomes larger than the circulation time and the depletion time so that appreciable deviations from chemical equilibrium occur. Particularly the abundances of C, HC_3N, H_2CO, CH_4 and C_2H_2 are significantly enhanced and those of CO, O_2 and N_2 are reduced compared with their equilibrium concentrations at the same depth. Comparison of the present results with those for chemical equilibrium circumstances presented in Paper I shows that the departures of chemical equilibrium affect the predicted column densities of H/T, H_2CO and HC_3N significantly. It appears that the time-dependent model can account for the HC_3N column densities observed in L183 and TMC-1.

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