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CELLULAR AUTOMATA MODELLING OF THE CEMENTATION PROCESS OF THE TURIN (ITALY) SUBSOIL CONGLOMERATE ("CEPPO"), BASED ON A THREE-DIMENSIONAL GEOLOGICAL MODEL OF THE CITY SUBSOIL.

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The Turin (Italy) subsoil is mainly made up by alluvial gravels and sands (Pleistocene), characterised by high cementation degree variability, covered by a thin thickness of loess. These alluvial sediments, of about 40 m deep, overlay lacustrine clays (Villafranchiano), locally heteropic with marine sandstones (Pliocene).
The reconstruction of the areal distribution of cementation phenomena of the Turin urban subsoil is of fundamental importance within the context of planning and carrying out works in the city subsoil, as well as for preliminary evaluating the stability of such underground works. Moreover, analyses of spatial distribution of soil cementation could be usefully applied for estimating the propagation of waste-polluted fluids, and for reducing either the natural or human-induced risk, related to the overworking of urban area subsoils.
The development of mathematical models commonly needs to deal with several interacting physical and chemical phenomena. A deterministic Cellular Automata (CA) model for the evaluation of cementation processes in the conglomerates of the Turin urban subsoil has recently been developed, by using a three-dimensional geological model of the city subsoil based on boreholes data. The model is able to simulate the spatial distribution of the cementation process in the studied area: it has been derived from two pre-existing CA models, i.e. SCAVATU and CABOTO.

Geological, mineralogical-petrographic and sedimentological studies of the soil cementation, and a chemical-physical study of the carbonatic equilibria, have first been carried out. These studies pointed out the presence of meniscus cements (which suggest a meteoric diagenesis) and gave fundamental cues for the development of base hypothesis on the genesis of cementation in the considered area.
A macroscopic Cellular Automata model has accordingly been developed, in order to simulate the principal phenomena which take place during the cementation process. The model has a ”layered structure”, composed of the following three layers: 1) the first quantitatively describes pluviometric events in the Turin area. The global amount of rain is subdivided into ”run-off” and ”infiltration”, by using the c.i.p. value. This layer concerns only the space region in which the run-off occurs: such cells have been classified as ”A” type. 2) the second layer describes the fluid flow of ”water” through the soil (i.e. loess and conglomerate). It concerns the space region of the Turin subsoil: such cells have been classified as ”B” type. 3) the third layer describes the chemical-physical phenomena of ”solute transport”, ”diffusion and chemical reactions of dissolution”, and ”precipitation of calcium carbonate”. Inside the above mentioned cells, the chemical-physical phenomena are allowed to occur. Owing to their high complexity, the global phenomena under consideration have been decomposed into ”elementary” processes (run-off, infiltration and chemical-physical reactions) and properly translated into CA local rules.
The model, opportunely implemented in a parallel computing environment, allows to simulate the process of cementation of the Turin urban subsoil: as mentioned above, it could be therefore usefully applied for mitigating natural and man-induced hazards in the study area.