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History of the development of groundwater system research in sedimentary basins

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Advances in our understanding of natural groundwater systems in sedimentary basins at different time and spatial scales have been achieved by fundamental and applied research by (geo)scientists and engineers from research institutes, industry and academia. The focus of this presentation is on reviewing the history of groundwater system research over the last 65 years, that is since Hubbert (1953) first described the influence of hydrodynamics on migration and entrapment of petroleum. Generation, migration and entrapment of oil and gas take place on time scales of millions to hundred of millions of years, and the location of conventional oil & gas fields is at depths of 2 to 5 km in onshore and offshore sedimentary basins. The recognition of the influence of hydrodynamics on the petroleum system was an important trigger to start research of pressure and groundwater systems at greater depths and covering larger – geological – time and spatial scales than studied until that time in relation to water supply for drinking and irrigation from mostly shallow gravity-induced meteoric groundwater flow systems. After an initial slow start research efforts increased during the 1980's and have advanced rapidly since the early 1990's. Important results include the identification, quantification, physical description and forward modelling of the different mechanisms that operate during the evolution of a sedimentary basin (such as sedimentary loading and unloading, tectonic compression, topography of groundwater level) and their effect on the evolution of pressure and groundwater flow systems; development of approaches to identify current and past groundwater flow conditions based on present-day characteristics of the sedimentary basin fill that are an observable result of the role of groundwater in geologic processes; hydrodynamic approaches to analyse and map measured pressures; a variety of applications of basin hydrodynamics, such as pressure prediction, assessment of fault and seal properties, hydraulic continuity and compartmentalization of aquifers, storage potential for produced water disposal, gas, CO_2, exploration for geothermal.
The groundwater geoscience and petroleum geoscience world have often operated separately in developing knowledge, methods, workflows and acquiring data with regard to pressure and groundwater systems. This resulted in emphasis on different research topics and methods. For example, in petroleum geoscience there has been a lot of emphasis on advancement of seismic interpretation, on development of basin modelling software with primary focus on application for petroleum exploration purposes, emphasis on pre-drill pressure prediction using logs and seismic approaches, on research related to sealing properties of faults and shales, on research of multiphase flow. A side effect is the use of different terminology for similar hydrogeological and hydrological phenomena (e.g. permeability vs hydraulic conductivity, overpressure vs hydraulic head, seal vs aquitard).
The presentation will treat the main research results developed in groundwater as well as petroleum geoscience world, and give examples of integration of research results. To deal with future challenges related to increasing subsurface activities and possible undesired effects at the surface, it is important to use and build on the wealth of existing data, knowledge and methods in future research.