Hydrogeology Journal: Foundations (pedagogy) articles

The International Association of Hydrogeologists (IAH) is a scientific and educational charitable organisation for scientists, engineers, water managers and other professionals working in the fields of groundwater resource planning, management and protection. Hydrogeology Journal is the official journal of IAH.

'Foundations' articles are published in the journal occasionally. These review articles cover subjects typically encountered in textbooks or taught in (under) graduate courses. The name Foundations was chosen because these subjects form the basis of our science. The aim is to provide a platform that allows fundamental topics to be treated in more detail than what is possible in textbooks. Foundations articles can also clarify common misunderstandings or misconceptions, or provide up-to-date coverage of a subject that has seen substantial recent developments, which are not yet covered in textbooks. The educational aspect is a key characteristic of this article type, and a Foundations article is likely to have a strong methodological focus. While it is not impossible for these articles to report on new research outcomes, they will typically be based on and reference research outcomes published in the literature, at least for the largest part.

The background to Foundations articles is explained in "Editor's Message: Hydrogeology education, textbooks and 'Foundations' articles", Hydrogeology Journal (2013), 21(4), pp 735-736, https://link.springer.com/article/10.1007/s10040-013-0977-0

Author(s) **Year, Vol/No, pages** **DOI**	**Title** **Abstract**
Vincent E. A. Post and Jos R. von Asmuth 2013, 21(4) pp 737-750 https://link.springer.com/article/10.1007/s10040-013-0969-0	**Review: Hydraulic head measurements—new technologies, classic pitfalls** **Abstract** The hydraulic head is one of the most important metrics in hydrogeology as it underlies the interpretation of groundwater flow, the quantification of aquifer properties and the calibration of flow models. Heads are determined based on water-level measurements in wells and piezometers. Despite the importance of hydraulic head data, standard textbooks used in groundwater curricula provide relatively little discussion of the appropriate measurement procedures. This paper presents a review of the literature dealing with the determination of hydraulic heads, and aims to provide quantitative guidance on the likely sources of error and when these can be expected to become important. The most common measurement procedures are discussed and the main sources of error are identified, i.e. those related to (1) the measurement instruments, (2) the conversion from pressure to heads, (3) time lag effects, and (4) observation well defects. It is argued that heads should be determined following well defined guidelines, and that it should become standard practice in hydrogeology to provide quantitative estimates of the measurement error.
Georg J. Houben 2015, 23(8), pp 1659-1675 https://link.springer.com/article/10.1007/s10040-015-1313-7	**Review: Hydraulics of water wells—head losses of individual components** **Abstract** Knowledge about the hydraulics of water wells is important to optimize their energy efficiency. By minimizing head losses around the well, energy consumption and ageing processes can be limited, thereby prolonging the well's service life. The contribution of the individual components to total head loss (drawdown) in the well is analyzed in detail. The single most important contributor to drawdown is commonly the aquifer. Its hydraulic conductivity can only be improved slightly through development. The second most important contributor is the formation of a wellbore skin layer. This occurs if no proper well development was performed after drilling; the layer contains remnants of drilling-fluid additives or mobilized fine aquifer particles. The head loss caused by groundwater flow in the gravel pack, through the screen slots and inside the well, was found to be small. Thus, well development is the most important measure to influence well performance and energy efficiency. For longer operation times and pumped volumes, the energy gains outperform the cost for the development.

Georg J. Houben 2015, 23(8), pp 1633-1657 https://link.springer.com/article/10.1007/s10040-015-1312-8	**Review: Hydraulics of water wells—flow laws and influence of geometry** **Abstract** Water wells are an indispensable tool for groundwater extraction. The analytical and empirical approaches available to describe the flow of groundwater towards a well are summarized. Such flow involves a strong velocity increase, especially close to the well. The linear laminar Darcy approach is, therefore, not fully applicable in well hydraulics, as inertial and turbulent flow components occur close to and inside the well, respectively. For common well set-ups and hydraulic parameters, flow in the aquifer is linear laminar, non-linear laminar in the gravel pack, and turbulent in the screen and the well interior. The most commonly used parameter of well design is the entrance velocity. There is, however, considerable debate about which value from the literature should be used. The easiest way to control entrance velocity involves the well geometry. The influence of the diameter of the screen and borehole is smaller than that of the screen length. Minimizing partial penetration can help to curb head losses.
Luke Flores and Ryan T. Bailey 2019, 27(1), pp 55-60 https://link.springer.com/article/10.1007/s10040-018-1843-x	**Review: Revisiting the Theis solution derivation to enhance understanding and application** **Abstract** The Theis solution is perhaps the most influential and frequently used analytical model in groundwater hydrology. Its publication in 1935 led to immediate and continued use for simulating hydraulic head drawdown, in both confined and unconfined aquifers, as a tool in aquifer parameter estimation. For educational purposes, the Theis solution and the related Jacob's approximation often serve as the backbone for teaching pumping-well theory, including topics such as boundary conditions in aquifers, image well theory, linear superposition, and pumping-induced streamflow depletion. Clearly, a thorough understanding of the Theis solution is critical for groundwater engineers and hydrologists. However, the solution often is presented as a "black box", neglecting the actual origins of its derivation and accompanying physical context. This can lead to misconceptions about the model and its inherent limitations. In this paper, a physically based detailed derivation of the Theis solution is presented, along with a method of calculating drawdown from a pumping well without resorting to the final Theis equation. Examples of both constant-rate pumping and variable-rate pumping are presented and compared to results using the original Theis solution. In particular, variable pumping rates are accounted for by direct numerical integration of an earlier form in the original Theis derivation, removing the need for linear superposition of solutions in time. In this way, it is hoped the paper will provide a method of calculation that ties the model user to the physical meaning of the solution, including its assumptions.
Hans-Olaf Pfannkuch, Howard D. Mooers, Donald I. Siegel, John J. Quinn, Donald O. Rosenberry, and Scott C. Alexander 2021, 29(6) pp 2001-2015 https://link.springer.com/article/10.1007/s10040-021-02363-7	**Review: "Jacob's Zoo"—how using Jacob's method for aquifer testing leads to more intuitive understanding of aquifer characteristics** **Abstract** The interpretation of aquifer responses to pumping tests is an important tool for assessing aquifer geometry and properties, which are critical in the assessment of water resources or in environmental remediation. However, the responses of aquifers, measured by time-drawdown relationships in monitoring wells, are nonunique solutions that are affected by many factors. Jacob's Zoo is a collection of graphical interpretations that allows students and practitioners to develop an intuitive feel for how natural hydrogeological systems work, and develop a set of skills that provide a better understanding of aquifer properties far beyond interpretation of pumping tests. Jacob's Zoo, based on the work of Jacob (1950), fosters a deeper understanding, although few practitioners realize the full utility of the method. Jacob CE (1950) Flow of groundwater, In: Rouse H (ed) Engineering Hydraulics, Wiley, New York. P 321–386.