# QUATERNARY GEOLOGY: A FAREWELL TO A. J. WIGGERS

## PREFACE

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Writing about Dr. Albert Johan Wiggers, at the very moment of the birth of this preface still functioning as General Director of the 'Rijksinstituut voor Natuurbeheer' (Research Institute for Nature Management), is a peculiar activity. Not on the least, of course, while the scope of his activities in no way tends to decline (on the contrary I would say), but also because of the description of his former position: ordinary professor in 'Physical Geography and Quaternary Geology'. A remarkable position as far as the Quaternary Geology so explicitely was concerned. A first and firm recognition of that branch of geology so closely related to the conditions themselves of our country?

The obvious question mark behind the last sentence and the nowadays crucial position of Wiggers in nature policy, so closely related to equilibrated use of Quaternary geological knowledge, offer arguments to put the extreme importance of Wiggers' activities against the background of the real significance of Quaternary Geology, specifically in the field of application.

The picture,however, is not that simple, for we should keep in mind that Wiggers himself was one of the primary architects of that background scenery. In order to underline the 'architect' function I will restrict myself to that field of Quaternary Geology which, to my opinion, has most of his heart: the geology of young marine deposits in delta's, lagoons, estuaries and coastal plains, as may reflect from his list of publications in which thirty titles out of the total of 51 are devoted to this type of deposits.

Moreover, the relation between the worldwide Dutch image as builders of their own country and geological science is nowhere closer than in this field of geology. Therefore Wiggers' contributions to the high standard of knowledge in our country, regarding this type of areas, rootes in a tradition for centuries.

I can imagine that in the meantime the reader is getting to be puzzled or even may be filled with unbelieve, when on the one hand is stated that there is a traditional rooting, while on the other hand the impression is given of a rather new field of knowledge, still foreseen with a question mark, supported by a few image builders among which Wiggers.

To my conviction this is a crucial point. The knowledge and experience on the caracteristics and behaviour of these types of deposits was already incorporated in our way of working for many centuries; not as a separate, well defined packet of knowledge, but already long ago incorporated in the necessary skill to carrying out works that where famous through the centuries. So this type of in fact geological knowledge never got its own profile and was more or less scattered among other disciplines that indeed developed from these activities such as civil engineering, water engineering and agricultural engineering.

On the other hand, when Quaternary Geology as a separate branch originated within the complex of earth sciences, it was kept restricted to almost pure science. Hardly any relations to practical use were made clear although as always exceptions were there. Staring, for instance, who made the first geological map of The Netherlands about the middle of the former century, complained bitterly about the lack of interest at the authorities regarding the natural richness of the country. His map indeed served an agricultural purpose.

The standard of pure scientific knowledge about the Quaternary deposits in our country increased, slowly at the beginning of this century, but after World War I in an accelerating way. Tesch, director of the Geological Survey guided a new mapping; Faber brought a lot of new geological insights in the geology of our country together in his books; Van der Vlerk and Florschütz shortly after World war II published a remarkable book on The Netherlands during the Ice Ages; but none of these efforts, except the new geological map of Tesch to some extent, brought the Quaternary Geology closer to a real social use.

From another corner, however, a highly important step was made. Edelman, a mining engineer teaching at the Wageningen Agricultural University, started soil mapping on

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the base of geogenesis, thus using geological patterns for agricultural purposes: a direct social application of Quaternary geological knowledge.

It is not my competence and it goes beyond the scope of this preface to describe further developments in soil mapping, but for a period of about twenty years Wageningen and the Stiboka (Soil Survey Institute) were in the lead regarding practical applications in the field of Quaternary Geology. Only when the new mapping of The Netherlands Geological Survey started in 1953, a purely geological institute showed a real interest in the applicability of Quaternary geological information to various kinds of activities such as civil engineering, space planning, agricultural techniques and, later on, environmental techniques.

In many respects this effort of the Geological Survey was supported by a general tendency to pay more attention to the use of earth-scientific information. Publications with a practical impact as well as activities of the 'Directie Wieringermeer' (nowadays part of the 'Rijksdienst voor de IJsselmeerpolders') based on geoscientific investigations and on the need for geological support recognised by the 'Deltadienst' of 'Rijkswaterstaat' played, among others, an important role.

In this framework Wiggers – since January 1st, 1951, head collaborator of the 'Directie Wieringermeer' – contributed to a high extent with a number of publications such as his thesis 'De wording van het Noordoost-poldergebied; een onderzoek naar de fysisch-geografische ontwikkeling van een sedimentair gebied' (Ph. D. thesis Univ. Amsterdam; Van Zee tot Land 14, Zwolle: 216 pp.) and a series of well known publications as 'De morfologie van het Pleistocene oppervlak in Noordholland en het Zuiderzeegebied, voor zover gelegen beneden gemiddeld zeeniveau (N.A.P.)' (TKNAG 75: 140-153), 'De Holocene wordingsgeschiedenis van Noordholland en het Zuiderzeegebied I' (TKNAG 76: 104-152), 'Soil survey and landclassification as applied to reclamation of sea bottom land in The Netherlands (ILRI, Wageningen: 60 pp.) and 'De Holocene wordingsgeschiedenis van Noordholland en het Zuiderzeegebied II'.

Caracteristic of most of these publications is the unraveling of subsequent genetic processes in a genetically consistent area at the hand of a mapping of lithostratigraphic units, and of C-14 datings, finally resulting in a three-dimensional model of the Holocene layer system of the area concerned.

Thus these publications indicate several ways, such as how to do it and how present it. Moreover they show a good potential regarding the question: 'how to use it?', not in the least because the lithostratigraphic units he used show a certain lithological consistence which makes them in this case more useful for practical use than purely chronostratigraphic units should.

It was not surprising therefore that Wiggers was added to the legend commission of the Geological Survey as a special advisor (1957-1963). So, many of his ideas and experiences are to be found in the legend of the running map production of the Geological Survey.

In the meantime the appreciation of Quaternary Geology as a specific branch of the earth sciences increased, not in the least because of a clearer image and a more distinct profile of its abilities, due to style of presentation in publications, maps and reports for practical purposes. Therefore the Free University of Amsterdam founded an ordinary professorate for Physical Geography and Quaternary Geology, in which position Wiggers started on the first of January, 1960.

## APPLIED QUATERNARY GEOLOGY

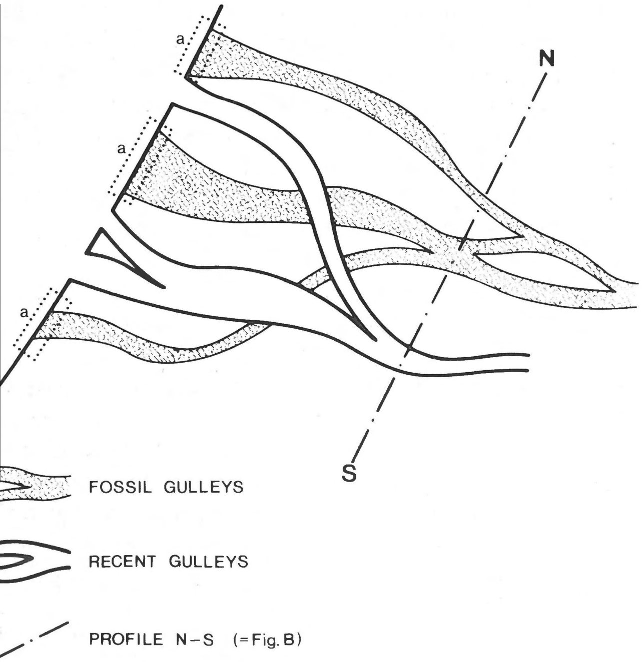
The foregoing may have left the reader with the impression that in fact I am dealing with a branch of the geological sciences of a disputable importance only reluctantly accepted. Therefore I suppose the best way to take away this feeling is to give a more direct and substantial description of what Quaternary Geology comprises. For this purpose I will focus on deltaic and coastal areas, an important domain of Wiggers' work and a specific Dutch subject at the same time.

Maybe the best way to convince about the important role of Quaternary Geology is to give a short impression of its abilities in relation to growing social problems such as the raw-materials supply (sand, clay and gravel), groundwater production, planning, environmental protection, and also its possibilities for the benefit of civil and agricultural engineering.

This impression is energetically directed on the use of this type of knowledge in deltaic and coastal areas all over the world in different stages of development and not specifically focused on our own country.

A major part of the possibilities for development of a country – and this applies particularly to the developing countries – is the optimal use of natural resources. Traditionally, this means useful minerals and/or raw materials for energy (coal, gas, oil). These resources determine to a great extent a certain (but not necessarily a permanent) level of prosperity. Another type of natural resources may, however, contribute to a more balanced minimum level of existence. These resources include raw materials for housing, groundwater for domestic, agricultural and industrial purpose, and also areas and locations which can be earmarked for specific agricultural or industrial purposes.

In view of the nature of the deposits in question (mainly the 'soft rocks') attention must be primarily focussed on deltaic, fluvial, estuarine and coastal areas. As a rule, such areas are the centres of development and prosperity as a result of their favourable connections with the sea and with the hinterland. Their fertility, the presence of groundwater, and a level topography make them potentially suitable for connecting roads and cause them to become prime areas of settlement. This means also a rapidly developing infrastructure with a high population density, a large demand on the groundwater potential, and a heavy demand on (but also a considerable pollution of) the surface minerals sand, gravel and clay for housing and other purposes.



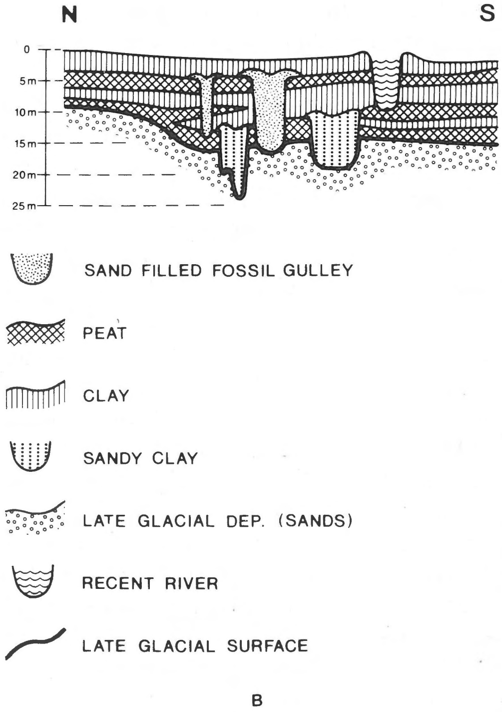




Fig. 1
Geological framework of a deltaic area. A: map. B: cross section.

During initial development, sufficient material will be available and areas for building can be easily indicated. This may introduce, however, the basis of an infrastructure, which is going to lead its own life and which cannot be corrected or rectified other than at great expenses and with advanced techniques. Such problems could have been avoided by infrastructural planning based on the geological patterns.

As an example, deltaic areas generally have a poor carrying capacity. A geological study may reveal a number of covered former riverbeds, filled with sand (See Fig. 1, A and B). These sandy tracts are ideally suited for roads, with low cost for construction and maintainance. The same sandy tracks may widen towards the coast, thus offering much better possibilities for building than the interjacent clayey or peaty areas (Fig. 1A).

On the other hand, such sandy tracks, when intersecting the coastline, may cause sliding down of sea defences by scouring, unless the danger is recognized in time and adequate measures can be taken. This shows the close relation between geological and ground-mechanical aspects (see Fig. 1A, sectors a).

Because of low sea stands during the preceding glacials – 10.000 years ago the sea level was still about 60 m lower than today – the erosion base was lower and subsequently in many cases coarse material was accumulated in lower river courses and coastal plains. Therefore in many sedimentary coastal plains these coarse deposits with high bearing capacity are to be found at depth from 5 to 25 m below the recent surface. In coastal plains of such type this layer mostly forms the base for pole structures for buildings etc. However, the surface of this layer may be irregular either by origin or by later marine erosion, with height differences of ten metres or more sometimes over short distances (Fig. 1B). This again means a big difference in suitability of locations from the point of view of constructional difficulties, amount of concrete to be used and costs all related to this specific form of 'natural richness' which is related to geological patterns.

By an efficient and justified use of natural patterns, damages can be avoided, the repair of which requires expert knowledge that may not be available for many, many years. The rapidly growing demand for building materials should be preferably covered by local supplies. In view of the specific requirements of sands for mortar, concrete or other industrial purposes, only specific and often scarcely present sand deposits can be utilized. These must be located and evaluated, and they should be kept accessible, instead of becoming unavailable by rigid elements of infrastructure and to avoid their being used for other lower-priority purposes, e.g. filling-up and/or raising-up certain construction levels. The same considerations can be applied to gravel and clay.

For groundwater – the working field of hydrologists and geologists – it is also of importance to establish the current pattern and the supply in order to exercise a management directed towards continuity without causing damage to other interests. It is a fairy-tale that lowering a pipe into the ground solves the problem of water supply, even if in some low soft-rock areas water might be produced by this method.

Drawing water as a rule causes a forced movement of water in the subsoil to replenish the withdrawn quantities. This movement may be either vertical or lateral. A vertical movement may cause a lowering of groundwater level and subsequently a drying-up. Lateral movements may attract water of poor quality, e.g. sea water or polluted water from distant intake areas. Finally, salt water from greater depths may be attracted by vertical and/or lateral movements. It should be realized that a subterranean basin, once polluted, remains practically inusable for ever.

To make the best use of available water supplies, particularly when these are scarce, the better water should be primarily used for consumption, whereas lesser qualities may satisfy the demand for industrial and other purposes. But also to protect the groundwater against pollution by human activities, the current pattern should be known and the intake areas should be protected against defilement.

It is self-evident that agricultural techniques should be adapted to an efficient management of groundwater supplies. Withdrawal of water, coincident with agricultural development, causes a lowering of the groundwater level that may have serious consequences for the same agricultural activities. For this reason, a well-considered development of agricultural techniques must be integrated in the total management of available water supplies. For these reasons it is imperative to handle water reservoirs with expert geological knowledge.

Thus it can be stated that deltaic areas, lower coastal areas and lower courses of rivers (all of which are mostly soft-rock areas) contain a considerable amount of natural resources, consisting of raw materials (sand, gravel and clay) and the vitally important groundwater. In addition, the mentioned areas have clearly preferent localities for certain types of settlements, for road tracks, harbours, dikes etc., thus enabling Man to build simpler, cheaper and longer-lasting. A proper earth-scientific knowledge provides the essential information for efficient construction and for avoiding possible calamities. Neglecting the possibilities offered by nature means the loss of prosperity at whatever level and an ever threatening loss of human lives.

## SITUATION IN THE NETHERLANDS

The Netherlands indeed are to be considered as a leading country regarding knowledge and experience in Quaternary Geology and its applications. This is shown, for instance, by top performances in civil and agricultural engineering in which, as stated before, a great deal of earth-scientific knowledge is anonymously integrated.

Wrong decisions, however, have also been taken in our country, either by neglecting the advantages offered by the 'third dimension' (in our case the Quaternary subsoil), or by making important sources of raw materials inaccessible. Other activities have threatened the health of subsoil and groundwater. Learning from these mistakes instead of waving them away, means another important source of knowledge and experience.

Especially in this respect the position of applied soft-rock geology is threatened in our country, since historically it is to a great extent incorporated in the field of engineering activities instead of being developed anonymously. Thus criticism on planning and execution can, from the point of view of soft-rock geology, hardly generate from a well profiled and independent scientific branch, since in many respects it is to be considered as bound to the planning and executive organs.

### *The influence of Wiggers*

In this respect the decision to install a chair for Quaternary Geology was a lucky one, although in my opinion still a far too small effort in this field, regarding the modest scale in which the subfaculty of the Free University has to operate yet. That other universities did not show interest in activating Quaternary Geology to a level that would really cope with the needs for well-profiled applicable knowledge in this field, is to be deplored. It has led to the situation that knowledge of Quaternary Geology in our country nowadays mainly is restricted to the Free University of Amsterdam (with its modest possibilities) and The Netherlands Geological Survey, instead of being shared with other Dutch geological university institutes. My personal position may underline this situation.

Wiggers, in his chair at the Free University, used his 'monopoly' to make a specific school based on what he had been doing already so utmostly successful: the geology of young marine environments. Teaching his students with great feeling for the equilibrium between pure science and application, he developed a school that created Quaternary geologists finding their way as well in practice as in pure science, depending on their personal abilities and interests.

Of course, other fields of Quaternary Geology also got his attention and this resulted in papers on glacial phenomena like:

Jungerius, P. D. & A. J. Wiggers 1971 The effects of selective erosion by overland flow on the ice-pushed ridges of Uelsen (county Bentheim, Germany) – Geol. Mijnbouw 50: 425-428.

Bos, R. H. G., P. D. Jungerius & A. J. Wiggers 1971 Solifluction and colluviation on the ice-pushed ridges of Uelsen, Kreis Grafschaft Bentheim, Germany – Geol. Mijnbouw 50: 751-754.

A. J. Wiggers 1973 De geologische werking van ijs, sneeuw en vorst; de ijstijden. In: A. J. Pannekoek (red.): Algemene Geologie – Tjeek Willink (Groningen): 367-410.

Meanwhile the articles on Holocene marine deposits went on with titles as:

Van Loon, A. J. & A. J. Wiggers 1975 Litho-, bio-, and chronostratigraphy of the Holocene Dutch 'sloef' (Almere Member of the Groningen Formation) – Meded. Werkgr. Tert. Kwart. Geol. 12: 3-24.

Van Loon, A. J. & A. J. Wiggers 1976 Abrasion as an agent for sand supply in a Holocene lagoon (Almere and Zuiderzee Members. Groningen Formation) in The Netherlands – Sediment. Geol. 15: 293-307.

Other articles, however, revealed his lasting interest in the relation between earth sciences and the activities of Man in the environment. A problem that he estimated of high importance gave rise to publications as:

Wiggers, A. J. 1967 De manipulaties met het fysisch milieu. In: Ruimtelijke ordening en geografie – Leiden: 20-26.

Wiggers, A. J. 1970 Over de betekenis van een kwart eeuw onderzoek door de Stichting voor Bodemkartering voor de Nederlandse geografie – Geogr. Tijdschr. 4: 388-396.

Wiggers, A. J. 1970 Functionele fysische geografie – Geogr. Tijdschr. 4: 296-302.

Wiggers, A. J. 1970 Landschapstypologie van Nederland. In: J. C. v.d. Kamer (ed.): Het verstoorde evenwicht – Utrecht: 102-110.

The attitude speaking from these titles, together with his ambition to function in the field of social decesion-making, made him accept his present function in 1977: General Director of the Research Institute for Nature Management. Nevertheless, he continued for another four years his activities at the Free University of Amsterdam as an extraordinary professor, thus still giving the advantage to a group of students to profit from his abilities to combine science and social needs in a perfect harmony.

His decision to devote himself from now on exclusively to the 'Rijksinstituut voor Natuurbeheer' to a great extent has to do with the essence of this preface: the necessary efforts to bring Man's activities in harmony with the potency of Mother Earth.