

A reference dataset for the Neogene lithostratigraphy in Flanders, Belgium

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ABSTRACT. Subsurface research often makes use of information from locations where subsurface investigations occurred or that had temporary outcrops. In time, data and knowledge of these locations increases, though compilation of the former information, and uniquely identifying these in subsequent publications is seldom done. Data quality control and documentation are therefore required, including tracing the data sources to their unique reference in governmental databases. In this paper, a five-step approach is described on how all relevant data can be uniquely combined into a reference dataset for the Neogene of Flanders. The dataset is made available in the online web portal for soil and subsoil in Flanders. The individual data points, as well as the reference dataset, can be consulted and are re-usable in an accessible format by scientists, professionals and citizens with an interest in the subsurface, and even so by machines. The reference dataset approach can be elaborated for other subsurface data collections and is proposed to evolve to a standard practice for open subsurface data in Flanders. It increases the visibility and the quality of the data and the research. Inclusion of a reference dataset URL in research or other portals further contributes to data and knowledge integration. Such an open data approach is pivotal for (governmental) data management institutes providing geological services that facilitate a more sustainable use and management of the subsurface.

KEYWORDS: subsurface, archive, open data management, research portal, research data, quality control.

1. Introduction

The Neogene state-of-the-art compilation by the Subcommission for Neogene and Paleogene Lithostratigraphy of Belgium, formed an excellent opportunity to collect the data points to which the individual publications refer and to identify these data in the federal and regional databases. Two main data holders provide structured information concerning boreholes and outcrops of the geological subsurface of the northern region of Belgium, where Neogene deposits underlie the Quaternary sediments: (1) the regional Flanders Soil and Subsoil Database (Databank Ondergrond Vlaanderen or DOV), and (2) the federal Geological Survey of Belgium of the Royal Belgian Institute of Natural Sciences (GSB-RBINS).

DOV (<https://www.dov.vlaanderen.be>; 2020) is the public web portal for open data concerning geology, natural resources, soil, hydrogeology, geotechnical characteristics and groundwater licenses of the (sub)soil of Flanders. The Flemish Planning Bureau for the Environment and Spatial Development (VPO) of the Department of Environment & Spatial Development is responsible for the durable management and use of the subsurface, including the natural resources and the deep subsurface (-500 m TAW) (Departement Omgeving, 2020). VPO is also responsible for the geological data and information available on the DOV-platform. In addition, VPO manages the soil data in cooperation with all relevant stakeholders in that domain and coordinates the development of DOV.

The GSB-RBINS manages an archive of, amongst others, temporary outcrops and boreholes in the Belgian subsoil (RBINS, 2020).

Geological reports and scientific publications rely on and refer to, amongst other, data types, boreholes, cone penetrations tests (CPT) and outcrops, often without a unique reference to one of these data collections. Often the points are only referred to by the name of the village, assuming the readers have a-priori knowledge of the data, or have no need for more detailed information. Correct re-use of the data in future research, correlations and projects of any interest becomes a challenge. How can we do better in managing the datasets on which subsoil research in Flanders is based and in making them easily available for the public at large? What is in it for the scientists, the government and data and science portals? Here, a five-step approach is proposed for identifying, collecting and referring borehole and outcrop datasets for the Flanders region.

2. A federal and a regional geological data source for Flanders

The Geological Survey of Belgium (GSB) was established as a Geological Survey by a Royal Decree of 16 December 1896.

Being commissioned with the “study of extraction materials and water theory”, GSB focused on subsurface data collection and management, including physical collections. In a Royal Decree of 1919, the geological mapping of Belgium was officially assigned to the GSB. Still today, the data archives of the Belgium territory can be consulted in physical form and are nowadays also available in digital format.

This federal archive consists mostly of borehole data collected, end 19th and begin 20th centuries by geological mapping and also more general after 1939 when it was enforced by law to declare each borehole deeper than 30 m to the GSB. In most cases, also lithological descriptions were delivered. Subsequently, a geologist of the GSB added a geological interpretation. Data points collected in geological projects in which the survey is involved are also added. Originally only paper copies were available, accompanied with a map showing the locations of the data points. At the end of the 20th century, all descriptions and coordinates were digitized and transferred to a text file and database. The ascii-files are available on the collection website of the RBINS. This federal archive forms the first data source of many geological data projects, including for the regional DOV.

In 1980, following Belgian state reformations, the Flanders region became the competent authority for the environment, including groundwater, natural resources and protection of environment. The competence for acquisition, collection, management and publication of subsoil data for the Flanders region combines coherently and has been officially managed in the partnership of DOV.

DOV was founded in 1996 as a collaboration within the government of Flanders. Today, it is a network organization with many subsurface oriented stakeholders (De Keyzer et al., 2019). The three main partners, all related to Flanders (sub)soil policy, subscribed the DOV cooperation protocol in 2006, namely:

- Department of Environment & Spatial Development, Flemish Planning Bureau for the Environment and Spatial Development (VPO), responsible for soil and subsoil policy, research, monitoring and evaluation;
- VMM, Flanders Environment Agency, responsible for groundwater policy;
- Department of Mobility and Public Works, Geotechnical Division, responsible for geotechnical research and measurements.

The subsurface policy and advise in Flanders are built on this vast amount of DOV data and on the expertise available through this cross-thematic network. The DOV portal has a central role in geological projects directed by the Flemish regional government, but also serves as the information platform for subsurface data of Flanders for external users (De Nil et al., 2016). During

the regional geological mapping program, started in the 90's, archives of several federal, regional as well as research institutes were digitized and collected in the DOV database (Vandenbergh et al., 2015). Hereby, the archive of the GSB was the major data source. A structured database and the spatial context were key aspects of the new geological map data system (Jacobs et al., 1993). This program was the base for the structured geological information in DOV (De Baets, 2004). To date, historical data and interpretations, but also newly reported subsoil investigations and interpretations are re-used in new mapping and (3D) modelling initiatives. The DOV database serves as a prime source for the 3D geological mapping program of VPO by VITO (Flemish Institute for Technological Research) (Matthijs et al., 2013; Deckers et al., 2019) and for the H3O-cross-border models with the Netherlands (Verne et al., 2018; Deckers et al., 2014) by the GSB and VITO. Consequently, the collection of old and new data is the backbone of new tools, such as the Virtual Borehole (De Nil et al., 2018). Quality control of both archived and newly delivered data is a big challenge in keeping the database at a qualitative level. Since 2018, VPO also manages a subsurface sample repository in Vilvoorde, with data management supported by DOV.

DOV is in charge of implementing the requirements from the INSPIRE Directive (Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community) and will provide harmonised data from Flanders to Europe. Standardisation of the DOV database will ensure Flanders to be connected to the wider European geological context (Bartha & Kocsis, 2011), and facilitates querying and visualisation of the data. Recently, pyDOV, a community-based open source package, is developed to support machine-based extraction and conversion

of the data. This enables the integration of DOV data in larger data processing pipelines, and supports the reproducibility and/or repeatability of research studies (Haest et al., 2018).

The DOV map viewer (Fig. 1) allows (non-)geographical search by means of a location, names or other attribute information. The catalogue of webservices (<https://www.dov.vlaanderen.be/geonetwork/>) supports the use of the DOV data in user-GIS systems. Detailed instruction guides for the different modes of access to the data can be found on the DOV website.

Both the DOV database and the GSB archive are an important data source for subsurface projects of Flanders and Belgium. However, both data systems are not interlinked. Combining the information of the federal and the regional data infrastructure creates an added value. The coupling of information implies performing a quality check on the level of the identification of the individual data points as well as the metadata and interpretations available in the two data systems. Figure 2 illustrates the different steps of historical borehole documentation from the original written paper in the GSB archive to a standardised object of DOV in the context of the mapping program, with added interpretations resulting from geological projects carried out after this transformation.

2.1. Declaration of the boreholes

The shift in competent authority from the federal state to the regions for subsurface data, is reflected in different legislation concerning the declaration of boreholes. On the one hand, the Royal Order no. 84 of 28th of November 1939 determines that investigations of the subsoil deeper than 30 metres must be declared to the Geological Survey of Belgium. On the other hand, as from 1984, the groundwater management decree was

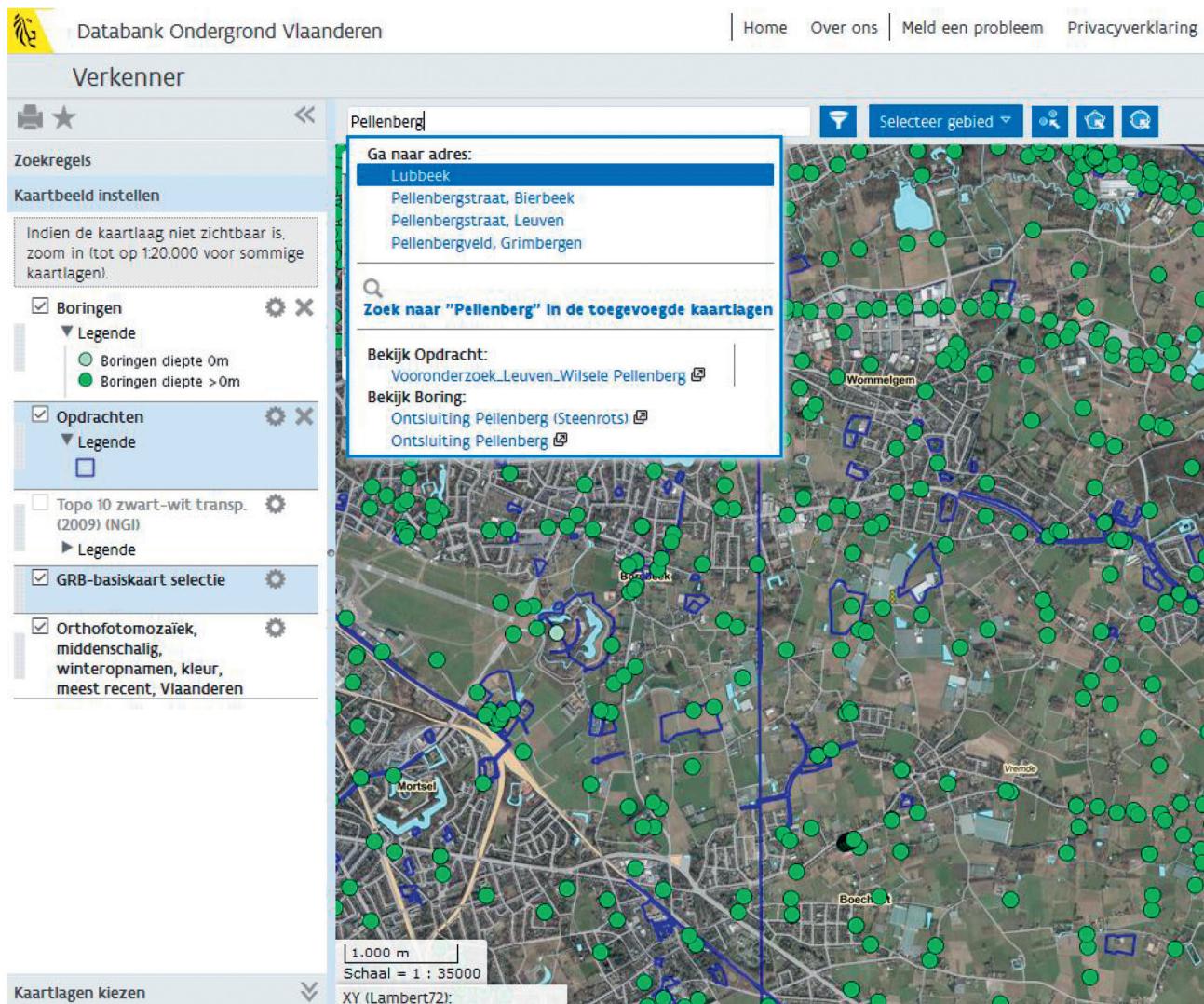


Figure 1. View of the activated search engine in the DOV map viewer, publicly available on <https://www.dov.vlaanderen.be/portaal/?module=verkenner>.

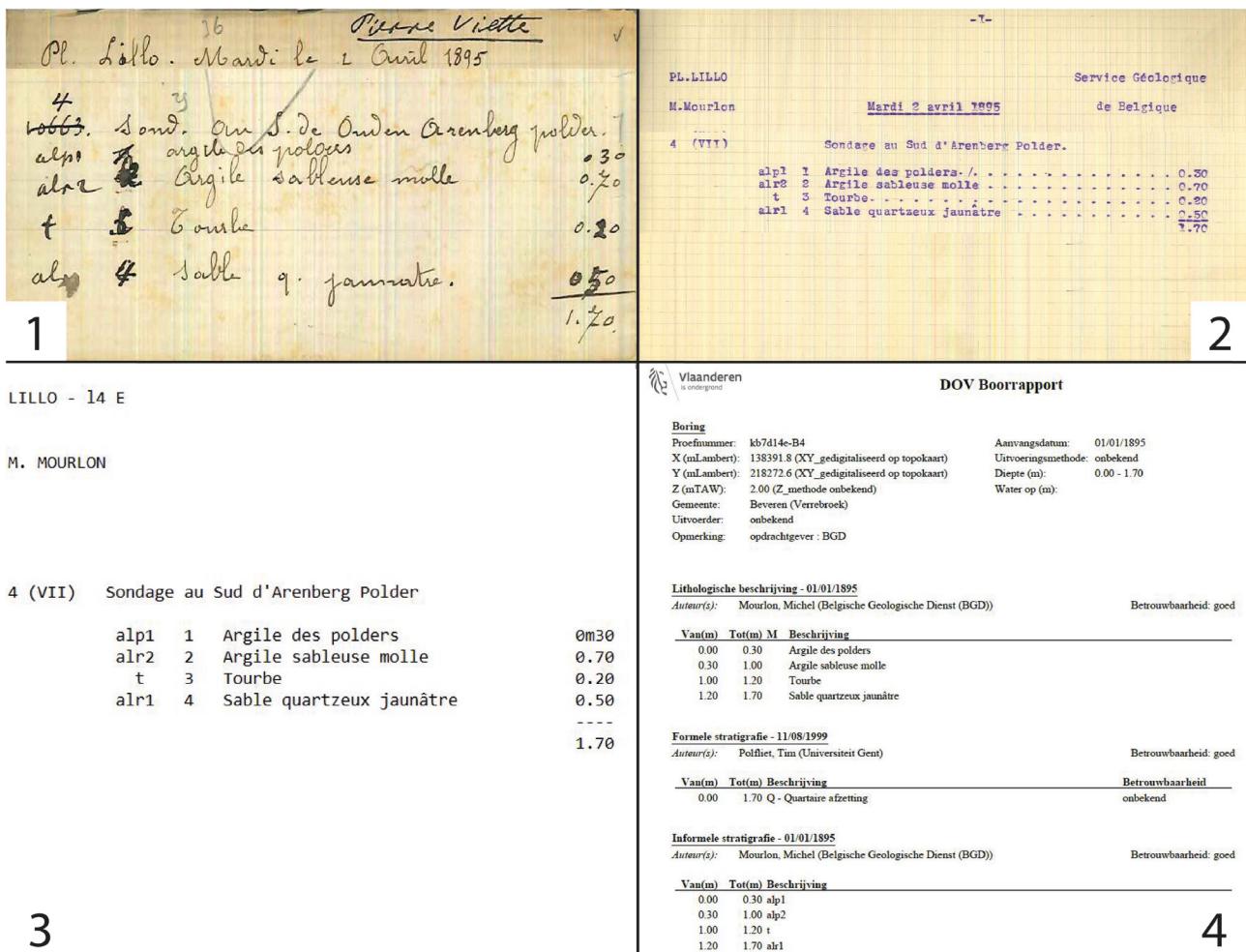


Figure 2. Pathway of information of an archived borehole from the GSB archive to the DOV database, with (1) the scanned written field description from the GSB archive, (2) the typed description in the GSB archive, (3) txt-format of the GSB archive, and (4) standardized DOV report of the same borehole with added interpretations as a result of geological mapping or modelling projects.

the base for the current groundwater policy in Flanders. Since 1999, VLAREM (Order of the Flemish Government of 1 June 1995 concerning general and sectoral provisions relating to Environmental Safety) regulates the drilling activities linked to the groundwater licences in Flanders. Since 2013 VLAREL (Order of the Flemish Government of 19 November 2010, establishing the Flemish regulation on recognitions relating to the environment) was extended: all the drilling companies, performing mechanical drillings in the subsoil of Flanders, are subject to a compulsory accreditation. As from 2017, this accreditation goes with an obligation to communicate all the drilling reports to DOV at least every two months. The drilling companies are responsible for the quality of the supplied drilling reports by their company. The VMM is the competent authority.

Next to this, boreholes in Flanders related to soil remediation and archaeological context also have their own specific legislation.

2.2. Identifiers for geological information points

Geological observations and measurements, including descriptions and interpretations, are, amongst other data types, the fundament of geological research.

Identifying this information and using the identifiers in the database in an unambiguous way is critical. The use of Uniform Resource Identifiers (URIs) is a way to uniquely name a data source. The use of stable data identifiers across datasets and publications creates opportunities for further data and knowledge integration. When those identifiers are HTTP URIs, so called URLs, users can discover the data easily (W3C, 2017).

In order to avoid mistakes when re-using interpretations of borehole and field data from previous work, it is important to use unique identifiers for data points.

The GSB and DOV each have their own, independent system of identifying geological information points.

2.2.1. Identifiers in the DOV regional database

DOV supports different types of names for boreholes and observations. Firstly, the objects have a DOV name. This name can be freely chosen, but must be unique. Mostly, it stems from the originating project of the boreholes in the database. Recent boreholes are named by the drilling companies managing their data in the database. Secondly, an observation can also have alternative names, which refer to names given to the object in other archives or reports. The (partly) freely chosen and unique object name is associated to a unique identifier. This unique, standardized 10-digit reference has the form: 'XXXX-XXXXXX'.

These persistent identifiers of a DOV borehole can also be used in URLs as from 2016, giving access to the objects' available information, compliant with the URI strategy in Flanders (Informatie Vlaanderen, 2017). An example of such a URL, including the persistent identifier, for borehole 'B/1-1101a' is <https://www.dov.vlaanderen.be/boring/2006-025143>. It refers to the current state of the digital object that is found online and in the database, independent of the application. The aforementioned URL provides the information on the object by default in HTML format (Fig. 3). However, other common formats, like XML and JSON, are also supported for particular types of use and applications.

All historical as well as current objects, in particular boreholes, interpretations, samples, cone penetration tests are characterised by this same type of unique identifier in the DOV database, namely "<https://www.dov.vlaanderen.be/> {object type}/{reference}".

Database history of these objects is available and necessary to keep track of changes over time. During quality control or further study, or as a result of mapping or modelling projects, changes or additions can be made to the data objects or to the linked

The screenshot shows a detailed view of a borehole record. At the top, it displays the borehole number (kb9d18w-B81), date (23/10/1962), depth (0,0 - 100,0 m), and various parameters like water level, slope, and direction. It also lists the contractor (Smet - Dessel Boormeester) and purpose (Geologisch onderzoek). Below this, a navigation bar includes links for Logging, Boorstaatgegevens, Namen (2), Grondwaterstanden, Wettelijk kader, Interpretaties (4), Monsters (78), Opmerkingen (1), and Bijlagen (1). The main content area starts with 'Locatie XY (in Lambert72)' showing coordinates X: 198022,00 and Y: 227253,00, along with method and origin information. It then details 'Aanvangspeil' (initial level) with three options: 'Opgemeten in mTAW', 'Is gestart', or 'Boven het maaiveld (m)', with the latter being selected. Below this is 'Maaiveld op het moment van de uitvoering' (construction level at execution) at 29,00 mTAW. Further down, 'Huidig maaiveld bepaald met DHMV II' (current level determined by DHMV II) is listed at 29,38 mTAW. The 'Liggings' section provides geographical context with 'Gemeente: Arendonk' and 'Deelgemeente: Arendonk'. A 'Beschrijving:' field is present but empty.

Figure 3. The URL of a database object, here borehole ‘Arendonk’ (DOV kb9d18w-B81, BGD018w0197, <https://www.dov.vlaanderen.be/data/boring/1962-024453>), allows the user to consult the drilling data, descriptions, interpretations, attachments and links, amongst which the link to the digital collection file as managed by the GSB.

objects of the data points, for example by adding interpretations or additional sample information.

Related data points can be gathered into a collection, namely by means of linking them to an assignment ('opdracht')-object data type. The relation between these data points can be based on the originating project, geological context, geographical distribution or any other relevant information. This assignment object also has a unique DOV-URL, including a persistent identifier. This allows easy reference to a collection of data by using only one URL. An example is <https://www.dov.vlaanderen.be/data/opdracht/2020-018771>.

2.2.2. Identifiers in the GSB federal archive

In the GSB, each geological information point (e.g. borehole, outcrop...) or data cluster (e.g. several boreholes on the same site) has been identified by the number of the geological map and a serial number since the 19th century (e.g., 071E0250). The number of the geological map consists of a number and a letter (W or E). The number of the map refers to the same area as the former topographic maps of the National Geographical Institute on scale 1/25 000. The map 071, for example, stands for the old topographic map 22/7-8. Within this map the east side is indicated with "E", so this makes 071E, and the west side of the map gets the letter "W". This map number is nowadays always four digits long. The number after the map name is also four digits long and is given at time of data entry in the GSB archive. Standardisation of the names for the data points is important in digital data management. In exceptional cases, the eight-digit number is followed by a small letter in the case there are several data points with the same name, but this is rather exceptional and nowadays never given to new data. The ascii files in the GSB-archive are available, ranked by map sheet, on <http://collections.naturalsciences.be/ssh-geology-archives/arch>. This file listing also has a search function in the top right corner of the page which allows the user to search for individual archive numbers and their corresponding files. Nevertheless, the individual archived files can also directly be accessed, using the link as follows f.e. <http://collections.naturalsciences.be/ssh-geology-archives/arch/001e/001e0001.txt>. Be aware to always use lower cases. In cases when the ascii-file is not yet available, it is also possible

to access a pdf-file, e.g. <http://collections.naturalsciences.be/ssh-geology-archives/arch/028c/028e0880.pdf>.

3. Identification, documentation and quality control of reference datasets

Since this Neogene-2020 update volume (Vandenbergh & Louwye, 2020) relies on a combined dataset of legacy and more recent boreholes, CPT and outcrop data, it is an ideal case study for testing the reference dataset approach. As typically done in more regional geological correlation studies, heritage data were used together with recently gathered data from boreholes or outcrops. This also required “upgrading” of the older geological data, for them to be used in a present-day environment (Vearncombe et al., 2017). Re-use of legacy data in a present-day digital and geographical context can be seen as a data rescue effort as well (Griffin, 2015). We aspired for the old, as well as the new data, the same degree of completion in the digital context. It is obvious that tracing back these points is necessary to avoid data mistakes, especially when referring to less recent observations.

In order to identify and document the reference objects of each paper in this Neogene-2020 update volume, we have applied a five-step approach:

1. Authors were asked to deliver a table with the base data for their manuscript, if possible based on the GSB number or the DOV name, and otherwise on the name of the data point in another archive, or the informal popular name of a data point, of which the significance is often well known amongst geologists.
2. Verification of the GSB archive number in the DOV database, together with the content of the data objects in the GSB archive and the DOV database.
3. Addition of the not yet referenced objects in the federal and/or the regional data system to the DOV database, and output of a standardised table to the authors.
4. Re-use of the standardised table in the manuscript of the authors. The data of these individual compilations are collected in the general Neogene 2020 volume assignment ('opdracht') and also in the assignment of the individual paper of the corresponding authors.
5. When all data are compiled, a DOI (Digital Object Identifier) is created for the dataset.

Step 1, the collection phase by the authors, involved compiling the identification, location and documentation of the used data in publications and data sources, and proved a major challenge. As a result of step 1, an individual list of data points, with or without GSB archive numbers and DOV names, was received from each leading author. In Step 2 of the exercise, the connection between the DOV data point and the corresponding number of the GSB archive was verified, based on the metadata, the location, the descriptions and interpretation of the observations in both databases. In this exercise, we encountered several problems. The object-based reference between the two data systems is not always correct. We also encountered ‘double objects’ in the databases, meaning that the same borehole activity was reported twice in a slightly different format, which resulted in two separate data points. Poorly georeferenced boreholes or even missing data objects in the archive or the database were noticed. In scientific publications or reports, boreholes and outcrops are often referred to by means of their location, and not necessarily by a unique code or name. Since, increasingly boreholes are drilled, the uniqueness of the historical borehole names, often based on their location, becomes more relative. The expertise of people involved in the drilling process, or the people involved in earlier scientific publications and reports was required in order to identify or localise some of the original boreholes and outcrops. Also incorrect coordinates in earlier publications proved problematic during this exercise.

Some data points of the author lists were not yet digitized in DOV or the GSB archive over the past years. In Step 3 all missing objects were entered into the DOV database, linked to the publication they are referred in, and available descriptions and interpretations were added.

Missing objects, with a specific link to the collections of GSB (e.g. samples, archives, pictures), were added to the GSB database.

In Step 4 a standardized table with the unique references of both data systems, when applicable, of the data points was handed back to the leading authors of the individual papers during the writing process. As the writing process was then in a more advanced stage, the data system managers asked the leading authors for a quality and completeness check of the standardized table. In some cases, this resulted again in a (minor) change of the lists. In that case, step 1 to 4 was retaken. All data listed were linked to a DOV assignment (‘opdracht’), grouping the data of the compiling Neogene 2020 volume, and complementary to an assignment grouping the base data of each individual paper of this volume.

Finally, after completing the individual datasets, a DOI will be created for the complete dataset. The DOI includes the URLs to the DOV assignments and a table of the reference data points.

Next to this five-step approach, guidelines were provided to the leading authors on how to refer to borehole data in the different manuscripts of this volume (Table 1). Authors with a compiled and quality-checked list of the base data points in their papers, can re-use the DOV assignment URL to refer to this compiled base data or they can re-use the URL to the individual data points in the database.

Table 1. Guidelines for the authors to reference the data in their manuscripts.

1. First use of a data point in the text: include the DOV and/or GSB name(s) of the objects, including the unique DOV-URL, for example:
 - o Boring Meerhout (DOV B/1-1117a, BGD 046W0389)
2. Further along in the text, the alternative name can be used.
3. Figures should at least contain or mention in the caption the reference to the DOV (including link) or GSB data.
4. The manuscript will have a compilation table in which a reader can find the data based on location or reference to DOV and GSB

4. Neogene reference data

4.1. Reference boreholes, (temporary) outcrops and CPTs of the Neogene deposits in Flanders

As a result of this case study, the borehole, CPT and (temporary) outcrop reference data points for the Neogene deposits (Adriaens & Vandenbergh, 2020; De Schutter & Everaert, 2020; Deckers & Louwye, 2020; Deckers et al., 2020; Dusar & Vandenbergh, 2020; Everaert et al., 2020; Goolaerts et al., 2020; Houthuys & Matthijs, 2020; Houthuys et al., 2020; Louwye & Vandenbergh, 2020; Louwye et al., 2020a; Louwye et al., 2020b; Munsterman & Deckers, 2020; Schiltz, 2020; Vandenbergh & Louwye, 2020; Vandenbergh et al., 2020; Verhaegen, 2020; Verhaegen et al., 2020; Wesselingh et al., 2020) in Flanders are identified. They are compiled in a DOV reference subset for each paper in this volume. Access to these subsets is given by the DOV URLs in Table 2. The individual data points in these subsets are also listed in Table 3 (boreholes and outcrops) and Table 4 (CPTs). Since the GSB archive numbers, and their corresponding URLs, are linked in this database, this number can be used in DOV to search for the original GSB archive documents for the objects in Table 3. All

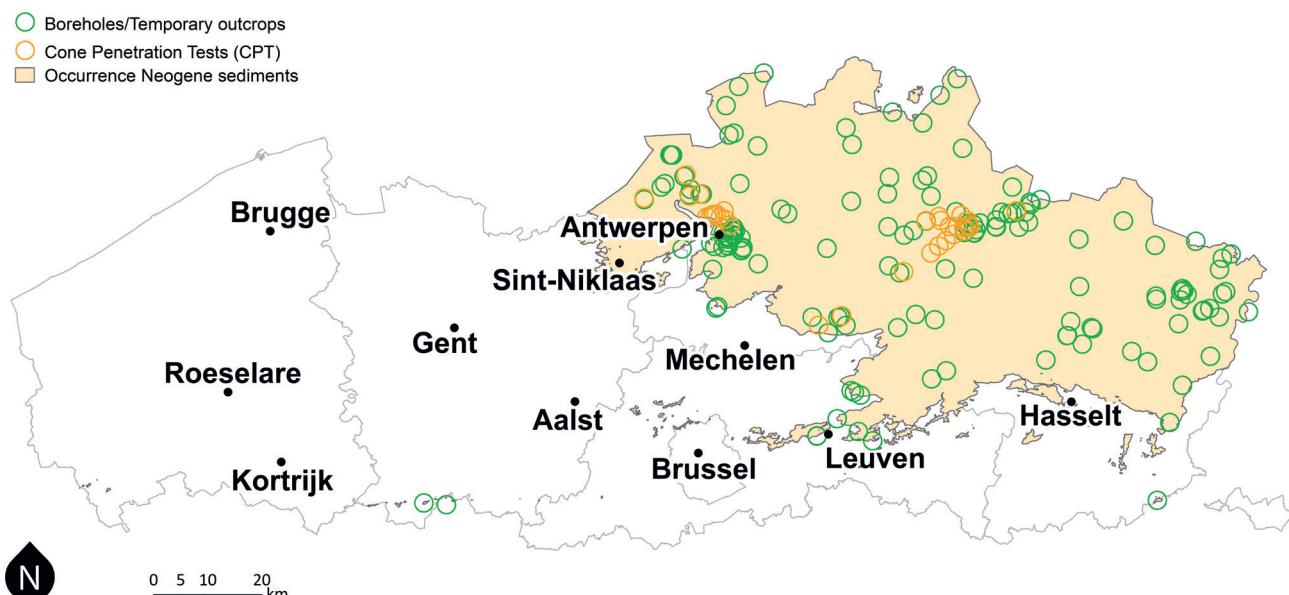


Figure 4. Distribution of the Neogene reference boreholes and outcrops (green) and CPTs (orange), all part of ‘NCS Neogene reference set’ in Flanders. The coloured zone is the Neogene occurrence map, resulting from the Geological 3D Model, version 3 (Deckers et al., 2019). All data and maps are available in DOV.

Table 2. The general and different (sub)reference datasets resulting from the individual Neogene 2020 papers, with their DOV URL.

Name of the DOV reference datasets of the Neogene	URL to the reference datasets
	General dataset of this volume
	(Sub)datasets of this volume
NCS_Neogene reference set	https://www.dov.vlaanderen.be/data/opdracht/2020-018771
NCS_Neogene 2020_Adriaens and Vandenbergh, 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-022012
NCS_Neogene 2020_De Schutter and Everaert, 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-022297
NCS_Neogene 2020_Deckers and Louwye, 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-022391
NCS_Neogene 2020_Deckers et al., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-023194
NCS_Neogene 2020_Dusar and Vandenbergh, 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-022386
NCS_Neogene 2020_Everaert et al., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-023193
NCS_Neogene 2020_Goolaerts et al., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-023222
NCS_Neogene 2020_Houthuys and Matthijs, 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-023176
NCS_Neogene 2020_Houthuys et al., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-021774
NCS_Neogene 2020_Louwye and Vandenbergh, 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-023242
NCS_Neogene 2020_Louwye et al., 2020a.	https://www.dov.vlaanderen.be/data/opdracht/2020-022192
NCS_Neogene 2020_Louwye et al., 2020b.	https://www.dov.vlaanderen.be/data/opdracht/2020-023227
NCS_Neogene 2020_Munsterman and Deckers, 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-022839
NCS_Neogene 2020_Schiltz, M., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-022689
NCS_Neogene 2020_Vandenbergh and Louwye, 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-023249
NCS_Neogene 2020_Vandenbergh et al., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-021580
NCS_Neogene 2020_Verhaegen et al., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-022424
NCS_Neogene 2020_Verhaegen, J., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-021804
NCS_Neogene 2020_Wesselingh et al., 2020.	https://www.dov.vlaanderen.be/data/opdracht/2020-023245

individual points from Table 3 and Table 4 are also coupled in the DOV collection object ‘NCS Neogene reference set’ (<https://www.dov.vlaanderen.be/data/opdracht/2020-018771>) (see Table 2 and Figure 4).

This entire collection is now a referable subset of the complete DOV database, linking to the individual data points, as well as to the scientific report(s) it is referred in. Table 2, Table 3 and Table 4 are also accessible via the DOI URL <https://doi.org/10.20341/gb.2020.021-SM1>, or by scanning Figure 5.



Figure 5. QR-code linking to the DOI dataset (<https://doi.org/10.20341/gb.2020.021-SM1>), including Tables 2, 3 and 4 from this paper.

This approach leads to several conclusions:

1. All data points referred to in this Neogene volume are collected;
2. As the volume is meant as the state of the art review of the Neogene stratigraphy of Belgium, all essential data points have been reported in the volume;
3. Of course, other Neogene data points exist, and can be searched for in DOV or the GBS archive (see Section 2).

More valuable data on the Neogene strata will become available in the future. DOV is the platform for updating this reference set. In consequence, the data set will keep its value as the reference set for the Neogene of Belgium.

4.2. Easily accessible reference dataset

Researchers have now at their disposal a data set of the relevant Neogene data points in Belgian geology with well-controlled identifiers and a correspondence between DOV and GBS data systems. All these data have already been used in the individual papers of this 2020 state of the art Neogene volume. These data points are a collection of boreholes, exposures and quarries, and CPTs, and are considered to contain the most relevant information on the Neogene. Each data point can be consulted and shows all geological and stratigraphical information available for that data

point. The newly created ‘NCS Neogene reference set’ offers the possibility to quickly explore these collected datasets. Exploring the data in the GSB archive can be done by accessing the collection website as explained in Section 2. Exploring them in the DOV database can be done in several ways: through the data portal, in your own GIS software using the DOV webservices or by scripts using pyDOV (see Section 2). The different papers, as subject of this case study, in this entire multi-author volume all rely on this dataset and have their own referable subset of reference data points (Table 2). The subsets are not directly linked to each other, but are connected through the individual data points. Each data point is part of one or more individual research publications, and also of the complete Neogene reference set. Every data point can also be part of an unlimited amount of other database collections, referring to different projects, publications or reports.

A DOI for this specific dataset is created to archive it, in a citable and findable way. It guides users to the complete reference dataset and to the different subsets.

5. Connecting subsurface data and science

Creating reference datasets reiterates the importance of the quality of data supporting any research project or other initiative. Mostly back tracing of non-uniquely identified data from former published articles or reports for large-scale databases is done via large-scale and intensive inventory and digitalisation efforts, if at all financially possible. Mostly however, this effort is done at the scale of the individual scientist during research phase and is not documented with the aim of re-use by others. During this exercise, we had the opportunity to create the dataset simultaneously with the authors of the different manuscripts. The interaction increases the authors’ responsibility to collaborate in the quality control of the used data during the data collection and research process, and facilitates the update of the documentation of these data in the large-scale databases.

By documenting the Neogene reference observation dataset in DOV in the scientific context, a dataset of higher quality is created, amongst many other (non-reference) borehole data in the database. For the government, a more qualitative database implies better policy support.

In the Table-set (see Section 4) a researcher can easily see in which paper(s) a particular reference data point has been used. Consulting the interpretation of a particular data point in the

Table 3 (continued)

Antwerpen, Kievitstraat A.K. outcrop	Antwerpen	kb15d28w-B453	028w0399			x		x		x						1965-120907	160165	227700	25.51
Antwerpen, Montignystraat A.M. outcrop	Antwerpen	kb15d28w-B448	028w0394			x		x		x						1966-119239	146610	222080	1.50
Antwerpen, Schijnpoort II A.S. outcrop	Antwerpen	kb15d28e-B583	028e0502	x												2016-147787	149671	218802	2.00
Antwerpen, Schijnpoort V A.S. outcrop	Antwerpen	kb15d28e-B582	028e0501			x										2016-147733	204260	212740	27.00
Antwerpen, Van Rijswijkstraat A.V. outcrop	Antwerpen	kb15d28w-B449	028w0395			x		x		x						1966-119240	238333	200867	50.00
Antwerpen, Zurenborg outcrop	Antwerpen	1436-B_19_Antwerpen _zurenborg_soiltech	-			x		x		x						2019-165026	238725	201000	51.00
Arendonk	Antwerpen	kb9d18w-B81	018w0197			x		x		x						1962-024453	239475	200325	62.00
Baarle-Hertog	Antwerpen	kb8d8w-B19	008w0150			x		x		x						1979-044219	195027	186206	58.97
Beerse, URS	Antwerpen	2022-167	017w0354	x												2002-160454	233996	162298	149.00
Beerzel	Antwerpen	kb24d5e-B159	059e0145	x												1962-103762	210178	213647	44.31
Beninkseberg, Hageland outcrop	Antwerpen	TO-20150101B	-	x												2015-163424	147811	219696	1.47
Berchem Post X, outcrop	Antwerpen	TO-20150701	028e0923			x		x		x						2015-170260	146667	222085	1.60
Bocholt	Antwerpen	B7-0356	033w0153			x		x		x						1995-025169	143987	226065	8.57
Boechout	Antwerpen	kb15d43e-B223	043e0205			x		x		x						1977-098612	144134	226051	9.20
Bolderberg	Antwerpen	kb25d62w-B270	062w0268			x		x		x						1930-031745	144299	226036	9.24
Borgerhout, Rivierenhof VII B.R., outcrop	Antwerpen	kb15d28e-B579	028e0498	x		x		x		x						2016-147730	144470	226019	9.20
Borgerhout, Rivierenhof XI B.R., outcrop	Antwerpen	kb15d28e-B580	028e0499			x		x		x						2016-147731	184400	205570	18.50
Borgerhout, Rivierenhof XIV B.R., outcrop	Antwerpen	kb15d28e-B581	028e0500			x		x		x						2016-147732	154820	210487	6.50
Borgerhout, Stenen Brug I.S.B., outcrop	Antwerpen	kb15d28e-B578	028e0497			x		x		x						2016-147729	155010	210796	6.00
Borsbeeksepoort I BP, outcrop	Antwerpen	kb15d28e-B576	028e0495			x		x		x						2016-147727	155468	211365	4.50
Borsbeeksepoort II BP, outcrop	Antwerpen	kb15d28e-B577	028e0496			x		x		x						2016-147728	156043	212009	4.30
Boudewijnsluis	Antwerpen	kb7d15w-B282	015w0131	x												1952-080889	155724	212190	1.50
Brasschaat	Antwerpen	kb7d15e-B330	015e0270	x												2016-147539	155660	212010	1.50
Burcht, outcrop quarry	Antwerpen	TO-20050101A	-			x		x		x						2005-163439	155730	212639	2.00
Churchilldok, outcrop	Antwerpen	BGD015W0307	015w0307	x												1965-175712	155481	212040	6.00
Churchilldok, outcrop	Antwerpen	kb7d15w-B285	015w0179	x		x		x		x						1964-115650	151512	209758	5.00
Dessel, Den Diel, pebblepit S1/A 1-0390	Dessel	kb17d31e-B319	031e0337	x							x					1981-085150	152232	209171	10.00
Dessel, ON-Dessel 1	Dessel	ON-Dessel-1	031w0300	x						x						1993-160110	153778	208970	12.00
Dessel, ON-Dessel 2	Dessel	kb17d31w-B299	031w0338	x				x		x						2002-096456	153881	211660	4.00
Dessel, ON-Dessel 3	Dessel	ON-Dessel-3	031w0354	x				x		x						2008-162468	160270	205965	16.31
Dessel, ON-Dessel 4	Dessel	ON-Dessel-4	031w0353			x		x		x						2008-160128	151858	204926	9.00
Dessel, ON-Dessel 5	Dessel	ON-Dessel-5	031w0370	x		x		x		x						2008-157945	177466	217497	19.30

Table 3 (continued)

Table 3 (continued)

Hukkelberg, sand pit	Kasterlee	TO-19630101	-			1963-161028	173194	193225	12.50
Kalmthout	Kalmthout	kb7d6e-B115	006e0089		x	1935-115750	192905	195618	20.00
Kalmthout	Kalmthout	kb7d6e-B155	006e0130		x	1980-021768	192295	184705	74.99
Kasterlee, N19 outcrop	Kasterlee	TO-20120101	-		x	2012-160763	220156	191107	62.00
Kasterlee, ON-Kasterlee 1	Kasterlee	ON-Kasterlee-1	030e0335		x	2008-160109	221821	194188	70.50
Kesselberg, outcrop	Kessel-jo	TO-20161025	-		x	2016-164491	222090	193960	73.02
Kinrooi	Kinrooi	kb18d49w-B230	049w0230		x	1995-102445	217403	192704	52.50
Lichtaart, sand pit Hoge Berg	Kasterlee	TO-19990101B	-		x	1963-160080	217307	192675	49.00
Lommel, Lommel-2, peilput	Lommel	kb17d32w-B379	032w0409		x	1981-022451	213390	188192	32.00
Lommel, Russendorp, peilput	Lommel	kb17d31e-B323	031e0341		x	1981-085133	237924	194897	65.00
Maarle	Ravels	kb3d4w-B355	004w0043		x	1980-1113811	229279	189752	77.00
Maaseik, Jagersborg	Maaseik	kb18d49w-B220	049w0220		x	1980-025921	243806	188878	44.50
Maaseik, Jagersborg	Maaseik	kb18d49w-B235	049w0236		x	1989-042715	242344	197232	56.25
Meerhout	Meerhout	B/1-1117a	046w0389		x	2006-067363	243674	197709	37.00
MHL 03/01, Maatheide,	Lommel	GEO-03/071-B2	032w0460		x	2016-133443	242583	197389	58.00
Millen - Elst, sand pit Mau-	Riemst	BGD107W0304	107W0304		x	2008-170593	245421	196156	35.00
Mol, Belchtim	Dessel	kb17d31w-B212	031w0221		x	1961-045029	232225	187857	81.00
Mol, ON-Mol 1, SCK	Mol	ON-Mol-1	031w0314		x	1997-160115	178783	174997	67.00
Mol, ON-Mol 2(B)	Mol	ON-Mol-2B	031e0440		x	2014-160122	236306	176664	88.50
Mol, Pidpa WWP8, put 8	Mol	B/1-96196	031e0435	x	x	2016-142724	197055	240100	25.08
Mol, Rauw	Mol	kb17d31e-B279	031e0287		x	1963-044892	156898	220757	9.89
Mol, Sas	Mol	kb17d31e-B280	031e0288		x	1963-085142	147540	218750	3.50
Mol, SCH Vriespij	Mol	kb17d31w-B267	031w0264		x	1980-1113596	149925	218817	2.70
Mol, SCH-K-15, peilput 1-0158	Mol	B/1-0158	031w0237		x	1975-117398	155815	230055	23.00
Mol, Sluis Pidpa	Mol	BGD031e0418	031e0418		x	1999-021261	154900	229725	25.45
Mol, VITO-KWO	Mol	B/1-96240	-		x	2016-142720	154330	235134	18.00
Molenbeersel	Kinrooi	kb18d49w-B205	049w0205		x	1906-082416	177608	227967	24.60
Molenbeersel, KB198	Kinrooi	kb18d49w-B226	049w0226		x	1987-042705	190600	221400	21.00
Muggenberg, sewer outcrop	Antwerpen	TO-19200101	-		x	1920-175301	192210	218431	20.11
Muziekberg, outcrop	Ronse	TO-20140501	-		x	2019-164498	191518	222183	21.70
Neerglabbeek	Oudsbergen	kb18d48e-B261	048e0248		x	1980-103657	184148	218885	17.75
Neeroeteren	Maaseik	kb26d64w-B221	064w0215		x	1911-082432	176484	231051	20.75
Neeroeteren	Maaseik	kb26d64w-B242	064w0234		x	1963-042750	190649	231963	30.90
Olen	Olen	B/1-1101a	045e0476		x	2006-025143	193848	237063	28.29
Olen, sluice outcrop	Olen	GRAN-BGD045w0253	045w0253	x	x	1972-002395	185120	233934	19.50
Oostmalle, Pidpa	Malle	kb16d29e-B276	029e0249		x	1976-116447	207212	220114	38.00
Oprimbie, outcrop	Oprimbie	TO-20170329	-		x	2017-164495	198022	227233	29.00
Opitter, Guitrode mill	Bree	kb18d48e-B153	048e0151		x	1896-041599	199117	213382	24.76

Table 3 (continued)

Opitter, mill second drilling	Bree	kb18d48e-B282	048e0269	x		1995-113522	198919	213868	23.54
Opitter, Molen sand pit	Bree	BGD048e0151C	048e0151	x		2016-136555	199156	213165	25.33
Opitter, Pollismolen	Bree	kb18d48e-B212	048e0206	x		1896-041651	198993	212703	25.22
Opitter, Quarry	Maaseik	kb26d64w-B217	064w0211	x		1920-042751	195615	212838	21.05
Opitter, seismometer	Bree	BGD048e0294	048e0294	x	x	2002-107078	19400	213951	17.24
Opitter, Solterheide sand pit	Oudsbergen	BGD048E0296	048e0296	x	x	2002-161064	200191	211622	24.88
Opoeteren, profile Gulink	Oudsbergen	kb26d63e-B1	063e0001	x		1901-111192	207958	215712	36.79
1964	Oud-Turnhout	kb8d17e-B497	017e0401	x	x	1998-083226	197761	214873	19.82
Overpelt	Overpelt	kb17d32e-B107	032e0128	x	x	1963-024571	196987	212852	23.39
Pellenberg, Hageland outcrop	Lubbeek	TO-20171107	-	x		2017-164496	210683	216967	44.61
Pellenberg, Steenrots, Hageland outcrop	Lubbeek	kb32d90w-B398	090w0939	x		2015-163426	201225	213501	21.89
PIN 03 3, Pinken, sand pit	Dessel	SIB-PIN-03-03	-	x		2019-162349	204289	214049	26.89
Poederlee, Pidpa	Lille	kb16d30w-B315	030w0300	x	x	1974-085996	155789	211079	6.00
Postel	Mol	kb9d18e-B30	018e0097	x	x	1962-024462	188892	212073	30.00
Postel, Postel-2, SCK13	Mol	kb17d32w-B385	032w0415	x	x	1982-022507	17650	194600	10.00
Posthofbrug, outcrop	Antwerpen	TO-20100101	-	x		2010-162793	175450	196250	30.00
Posthofbrug, PHB-2, outcrop	Antwerpen	TO-20150105A	-	x		2015-175060	21800	195300	60.00
Posthofbrug, PHB-3, outcrop	Antwerpen	TO-20150105B	-	x		2015-175061	172977	208817	9.10
Pottelberg, outcrop	Flobecq	TO-20140501B	-	x		2019-164501	187230	211250	28.00
Rees	Kasterlee	kb8d17e-B495	017e0399	x	x	1998-083222	139209	217815	2.20
Retie, ON-Retie 1	Retie	ON-Retie-1	031w0362	x	x	2008-157939	142380	220123	2.20
Retie, ON-Retie 2	Retie	ON-Retie-2	031w0375	x	x	2008-160132	157080	210700	7.50
Retie, Pidpa	Retie	kb17d31w-B228	031w0243	x	x	1976-085188	143050	220750	-19.40
Rijkveyor	Roosteren (NL)	kb8d16e-B37	016e0153	x	x	1975-083085	146229	208700	7.50
Rumst	Rumst	TO-20160916	-	x		1977-165105	152501	197778	20.30
RUS 04/03, Russendorp, Lommel	Lommel	RUS04/03	-	x		2016-164487	154591	209325	9.80
Scherpenheuvel-Zichem	Scherpenheuvel-Zichem	kb24d75e-B344	075e0340	x		1991-099007	157173	208393	12.18
Schilde	Schilde	kb16d29w-B290	029w0283	x		1977-085911	157472	208953	12.18
Schilde	Schilde	kb16d29w-B390	029w0372	x		1982-085939	157193	208428	10.40
Sint-Hubbrechts-Lille	Neerpelt	kb18d33w-B142	033w0139	x		1984-082391	157176	208370	5.20
Stramproy (NL)	Stramproy (NL)	B57H0058	-	x		1976-165104	157204	208447	9.70
Terhagen, outcrop quarry	Rumst	TO-20050101B	-	x		2005-163442	157217	208440	6.10
Tijmansstunnel, Tunnel Kanaaldok, outcrop	Antwerpen	BGD015W0304	015w0304	x		1965-175738	157414	208821	8.90
Tijmansstunnel, Tunnel Kanaaldok, outcrop	Antwerpen	GEO-61/2891-C	015w0144	x		1961-080825	157448	208857	9.90
Turnhout	Turnhout	kb8d17e-B494	017e0398	x		1996-083221	157147	208370	11.65

Table 3 (continued)

Table 4. List of the individual CPTs with reference to the different individual papers of this collection, sorted by DOV name.

DOV CPT name	Location/name	Municipality	Vandenbergh et al., 2020	Verhaeghen et al., 2020	Deckers & Louwye, 2020	Deckers et al., 2020	Schiltz, 2020	X (mL72)	Y (mL72)	Z (mL72) (mTAW)	DOV URL
08-CPTe-049	-	Mol	x			x	198425	212017	24.66	https://www.dov.vlaanderen.be/data/sondering/2008-077576	
08-CPTe-062	-	Geel	x			x	196347	211378	21.83	https://www.dov.vlaanderen.be/data/sondering/2008-077589	
08-CPTe-087	-	Geel	x			x	194993	210221	22.03	https://www.dov.vlaanderen.be/data/sondering/2008-077615	
08-CPTe-099	-	Geel	x			x	193597	209243	19.97	https://www.dov.vlaanderen.be/data/sondering/2008-077627	
08-CPTe-116	-	Geel	x			x	192190	207960	20.62	https://www.dov.vlaanderen.be/data/sondering/2008-077644	
08-CPTG-04	-	Dessel	x			x	198243	212647	24.68	https://www.dov.vlaanderen.be/data/sondering/2008-079150	
10-CPTe-137	-	Kasterlee	x			x	193657	214691	20.70	https://www.dov.vlaanderen.be/data/sondering/2010-077833	
10-CPTe-138	-	Kasterlee	x			x	191296	213922	23.40	https://www.dov.vlaanderen.be/data/sondering/2010-077834	
10-CPTe-79	-	Dessel	x			x	199335	212717	25.54	https://www.dov.vlaanderen.be/data/sondering/2010-077735	
10-CPTe-80	-	Dessel	x			x	198920	213866	23.56	https://www.dov.vlaanderen.be/data/sondering/2010-077736	
10-CPTe-81	-	Dessel	x			x	199158	213166	25.29	https://www.dov.vlaanderen.be/data/sondering/2010-077738	
10-CPTe-82	-	Retie	x			x	197760	214872	19.77	https://www.dov.vlaanderen.be/data/sondering/2010-077739	
10-CPTe-83	-	Retie	x			x	196988	212832	23.45	https://www.dov.vlaanderen.be/data/sondering/2010-077740	
10-CPTe-84	-	Geel	x			x	195610	212837	21.20	https://www.dov.vlaanderen.be/data/sondering/2010-077741	
10-CPTe-85	-	Kasterlee	x			x	193997	213953	17.00	https://www.dov.vlaanderen.be/data/sondering/2010-079170	
20140520-CPTe13	Postel-Rauw	Mol				x	207939	215708	36.68	https://www.dov.vlaanderen.be/data/sondering/2014-079153	
20140520-CPTe14	Postel-Rauw	Mol				x	207949	215708	36.75	https://www.dov.vlaanderen.be/data/sondering/2014-079154	
20140520-CPTe15	Postel-Rauw	Mol				x	207959	215707	36.71	https://www.dov.vlaanderen.be/data/sondering/2014-079155	
20140520-CPTe16	Postel-Rauw	Mol				x	207969	215706	36.65	https://www.dov.vlaanderen.be/data/sondering/2014-079156	
GEO-06/019-S12	-	Antwerpen				x	149503	218783	6.05	https://www.dov.vlaanderen.be/data/sondering/2006-053095	
GEO-11/062-S6	-	Antwerpen				x	154109	214186	5.46	https://www.dov.vlaanderen.be/data/sondering/2011-065237	
GEO-11/092-S1	Oevele	Olen	x			x	187142	204516	26.92	https://www.dov.vlaanderen.be/data/sondering/2012-064930	
GEO-12/132-S34	-	Antwerpen				x	151497	214784	6.52	https://www.dov.vlaanderen.be/data/sondering/2013-031612	
GEO-12/132-S70	-	Antwerpen				x	153247	214527	5.45	https://www.dov.vlaanderen.be/data/sondering/2013-031788	
GEO-12/132-S9diep	-	Antwerpen				x	150843	214617	7.00	https://www.dov.vlaanderen.be/data/sondering/2013-034117	
GEO-14/013-S105	-	Antwerpen				x	155047	213113	5.63	https://www.dov.vlaanderen.be/data/sondering/2014-036940	
GEO-14/112-S6	-	Antwerpen				x	147610	218447	7.74	https://www.dov.vlaanderen.be/data/sondering/2015-046949	
GEO-18/131-S6BIS	-	Antwerpen				x	153961	215708	5.63	https://www.dov.vlaanderen.be/data/sondering/2018-077392	
GEO-19/081-S5	-	Antwerpen				x	146961	222355	7.05	https://www.dov.vlaanderen.be/data/sondering/2019-079041	
GEO-90/154-SII(KAAI103)	-	Antwerpen				x	152526	215111	6.41	https://www.dov.vlaanderen.be/data/sondering/1990-069581	
GEO-95/004-SIX	-	Antwerpen				x	151926	215055	6.23	https://www.dov.vlaanderen.be/data/sondering/1995-003226	
GEO-95/004-SVII	-	Antwerpen				x	152095	214999	6.23	https://www.dov.vlaanderen.be/data/sondering/1995-003230	
GEO-97/138-SM196	-	Beveren				x	139169	218074	1.30	https://www.dov.vlaanderen.be/data/sondering/1998-005094	
WD-14/20140701-Sa	Beervel	Putte	x			x	171427	194606	46.50	https://www.dov.vlaanderen.be/data/sondering/2014-079151	
WD-14/20140701-Sb	Heist-op-den-Berg	Heist-op-den-Berg	x			x	175713	196362	45.50	https://www.dov.vlaanderen.be/data/sondering/2014-079152	

papers will help identifying remaining research issues as the same data point has not necessarily been given the same interpretation or led to the same conclusions in all papers. The papers in this volume have improved our understanding of the Neogene stratigraphy but have also identified important gaps in our understanding (Vandenbergh & Louwey, 2020). Future research on these gaps will benefit from the Table-set as the reference papers dealing with aspects of that issue are listed together with the main data used in each paper. Indeed the Table-set facilitates the composition of a new collection of data points across the present papers to start a new detailed study of a particular issue. In addition to the identifiers of this newly composed research collection, it also allows to select the key areas in which to search for additional data, at present not considered as reference data, by using the appropriate search methods (see Section 2).

This methodology of creating a documented, open and referable dataset linked to a(n) (open) scientific paper is in line with the Flanders Open Data Charter (Government of Flanders, 2018) and will be the basis for creating datasets according to the FAIR—Findability, Accessibility, Interoperability, and Reusability—principles (Wilkinson et al., 2016). The publication of a subsoil reference dataset as a findable and re-usable dataset is not yet common practice in Flanders, especially in a research context. Web portals are already in place to support this combined publication of datasets and papers. Increasing the interaction of the geoscientific publications on research portals, such as the FRIS portal (FRIS, 2020) amongst others, and their related datasets on data portals, such as the DOV portal for subsurface data, increases the impact of both types of portals in Flanders and highlights the importance of data. This exercise should be elaborated to a standard practice for the publication of subsoil datasets for geoscientific publications in Flanders, combining all relevant data types and maps of the subsurface.

The use of the URLs and unique keys for referring to the database objects or collections, connects the scientific articles to the wider database. Integrating the link to the scientific article in which the data were used in the database, connects the wide range of users to the scientific background of these data. As a consequence, this exercise also connects users, indirectly and by technical means: the scientific community gets connected to the wide variety of users of the database. If integrating these unique keys and URLs in papers becomes a standard practice for subsurface data, readers from other papers, not even related to this volume, will be able to explore other subsurface data and reference sets, leading them to quality checked data. As such, the original data may serve multiple purposes.

All of these efforts bring the importance of the created reference sets and their publications to a higher, European or even worldwide level and will further stimulate the Open Science movement.

6. Conclusion

Highly qualitative research and data are the foundation of a more sustainable and innovative subsurface management. When referring to subsurface observations and measurements, it is important to be able to refer to unique and persistent identifiers. It stimulates the correct re-use of data and increases the interaction between data publishers and data consumers. This is not yet a standard practice in Flanders for subsurface data and it is complicated since two data management institutes may be involved. In this paper, a workable approach is illustrated involving linking to the regional database for Flanders, with connection to the federal archive if applicable. Identification in open governmental archives and databases is important for a consistent (re-)use of the correct subsoil observations and measurements in research projects and resulting articles, and also for the correct geological interpretation based on the location of the geological description of the sedimentary environment. The methodology is developed and tested, together with the authors, to create a reference dataset for the Neogene boreholes, CPTs and (temporary) outcrops in Flanders. Such an interaction proved highly valuable and needed when creating reference dataset that inherently adhere to high quality standards.

The approach of creating this thematic dataset for the Neogene in Flanders increased the completeness and the quality

of the Neogene reference data in the DOV database. The quality of this reference sets should be maintained in the future by keeping it up-to-date with the state of the art descriptions, interpretations, additional research data and new relevant data points. The Neogene dataset is a prime example of a connected data collection, and a standard is set in how to include subsurface identifiers in scientific publications concerning the subsurface of Flanders. In the future, this methodology, preferably fully aligned with the FAIR-principles, should be continued adding more reference data points to the Neogene collection, and adding more reference collections to the DOV database. Including the link to these reference sets in both research and open data portals, raises the awareness of the importance of an unambiguous and qualitative dataset. It further stimulates re-use and connects stakeholders from (geo)scientific research and other initiatives.

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