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KVANE - A KVANEFJELD DRILL CORE DATABASE

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Abstract. A database KVANE containing all drill core information from the drilling programme carried out in 1958, 1962, 1969 and 1977 at the uranium deposit in Kvanefjeld, Southwest Greenland has been made. The application software "Statistical Analysis System (SAS)" was used as the programming tool. It is shown how this software, usually used for other purposes, satisfy a demand of easy storing of larger data amounts. The paper describes how KVANE was made and organized and how data can be picked out of the database. A short introduction to the SAS system is also given.

The database has been implemented at the Northern European University Computing Center (NEUCC) at the Technical University of Denmark.

INIS descriptors: DATA ACQUISITION SYSTEMS, DRILL CORES, GEOLOGIC DEPOSITS, GREENLAND, INFORMATION SYSTEMS, URANIUM ORES.

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INTRODUCTION

In connection with a geostatistical evaluation of the uranium-mineralization at Kvanefjeld within the Ilímaussaq intrusion in South Greenland, it was decided to establish a database containing all analytical information from the drilling programmes carried out in the years 1958 (Bondam, 1958), 1962, 1969 (Nielsen, 1969 and 1970) and 1977 (Nyegaard et al., 1977). The result of all the diamond drilling programmes were 70 holes with a total core length of approximately 10460 meters (fig. 1). Among these holes only a few are inclined with various dips while the rest are vertical. Each sample represents a one meter section. Drill cores from the drillings in 1958, 1962 and 1969 were sampled for every one meter while only every second meter of the drill core obtained in 1977 was analysed. The total number of drill core samples was 5663.

All 5663 samples were analysed for U, Th and K by gamma-ray spectrometry (GAM-SPEC). On the 1958 and 1969 samples a drill core scanning procedure was used (Løvborg et al., 1972) while all analytical work on the 1977 samples was done on crushed coresplits.

In addition to the gamma-ray spectrometry, an extensive analytical programme was carried out on the 1977 samples by various laboratories. This analytical programme involved the use of X-ray fluorscence (XRF), energy dispersive X-ray fluorscence using different radioactive sources (EDX-CD and EDX-PLU), optical spectrometry for Li and Be (OP-SPEC), fluorine-specific ion-electrode (F) and instrumental neutron activation analysis (ENAA). A summary discription of this work is given by Nyegaard (1979). Table 1 shows which analytical methods were used for each element. The table also includes the number of analyses, number of drill holes and a method index which will be explained later.
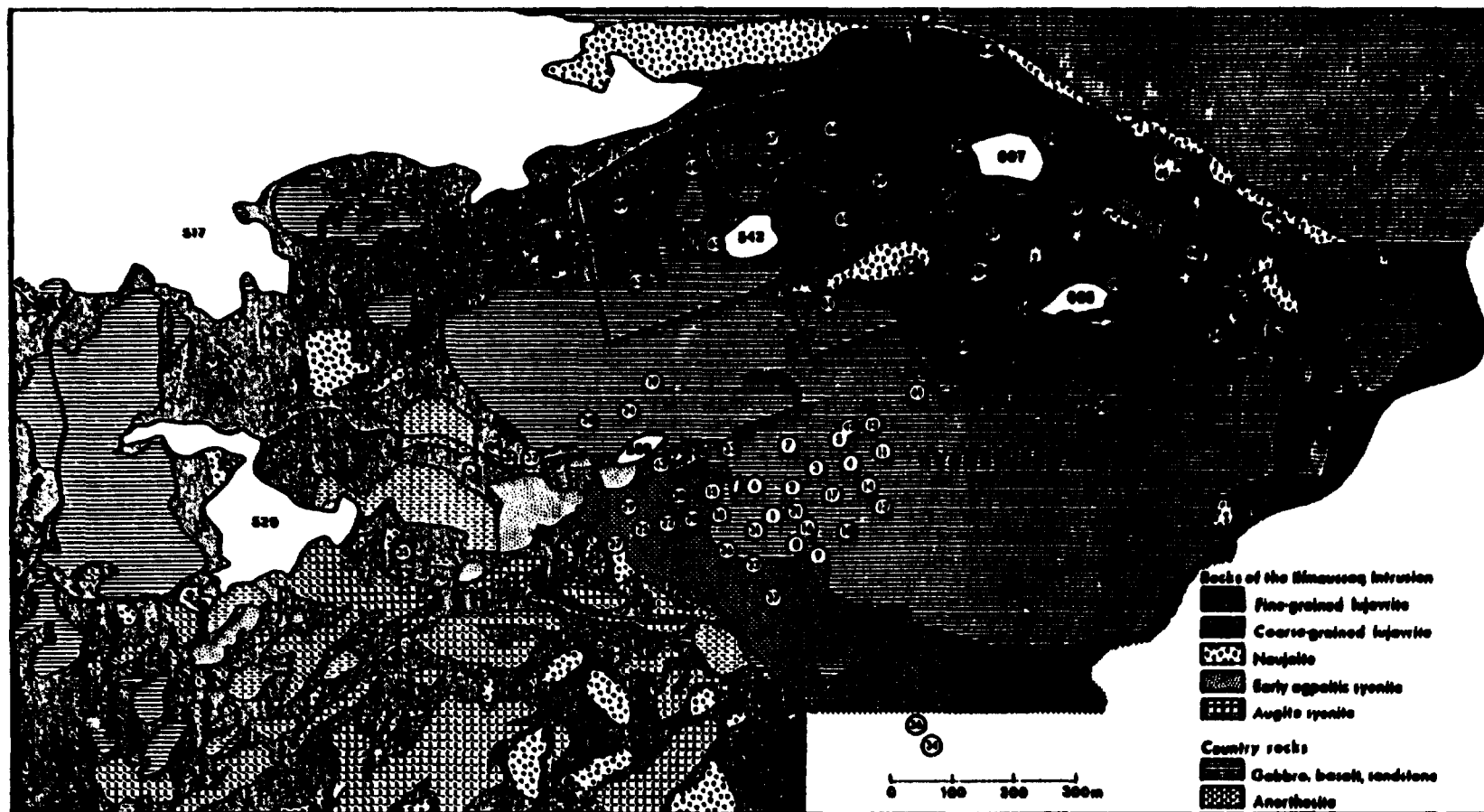
Figure 1. Position of drill holes in the Kvanefjeld area. The drill holes located in the area outlined by the solid line, was, exept for holes 29 and 40, drilled in 1977. (From Nyegaard, 1979).

Table 1. Summary table showing the analytical work on drill core samples.
Abbreviations used for analytical method and the Method Index are explained in the text. N_{cores} is the number of cores involved while $N_{samples}$ is the number of samples which was analysed by the method concerned.
&): Unreliable elements have been rejected.

Analytical Method	Elements obtained	N samples	Method Index	N cores
GAM-SPEC	U,Th,K	5663	1	63
XRF	Zn,Ga,Rb,Sr,Y,Zr,Nb,Pb,Th	614	2	7
EDX-CD	Fe,Rb,Sr,Y,Zr,Nb,Mo,Pb,Th,U	234	3	18
F	F	570	4	23
OP-SPEC	Li,Be	107	5	13
ENAA &)	Na,K,Sc,Cr,Mn,Fe,Co,Zn,Rb,Zr, Sn,Sb,Cs,Ba,La,Ce,Nd,Sm,Eu, Gd,Tb,Yb,Lu,Hf,Ta,Th	833	6	13
EDX-PLU &)	K,Ca,Ti,Mn,Fe,Ni,Cu,Zn,Ga,Pb, Sr	573	7	7

THE SAS SYSTEM

The database KVANE was installed in an IBM 3033 computer at the Northern European University Computing Center (NEUCC) at the Technical University of Denmark. Since IBM computers in general are not particularly database-oriented, a need for an alternative database-software arose. The Statistical Analysis System (SAS) was found to satisfy this demand, especially from the user's point of view. SAS is a software-package which is

normally used for statistical purposes (Barr et al., 1976).
SAS works independently of other software systems because it
has its own PL1-like programming language for data manipulation.
The fundamental feature of the SAS system is the creation of
a SAS data set, i.e. the database, on which further statistical
work can be done. A SAS data set can be compared to a two-
dimentional matrix where each row represents one observation
(e.g. one sample), and each collumn one variable e.g. an ana-
lytical value, an alphnumeric identifier, etc.). In figure
2 an example of a SAS data set is shown. The variable OBS
(observation no.) is created by SAS.

OBS	SAMPLE	URANIUM	THORIUM	DEPTH	GEOLOGY
1	234411	145.1	327.8	17.2.	332
2	234412	167.9	456.2	18.4	118
3	234413	258.0	362.9	19.1	118
4	234414	144.4	532.7	20.3	333

Figure 2. SAS data set with dummy values. The data set contains
5 real variables and an internal variable OBS and has four
observations.

The SAS-language, which includes the most common programming
options as IF THEN, GO TO and assignment statements, is nor-
mally used on the stage where the SAS database is made. It
differs from other languages like FORTRAN and ALGOL because
DO-loops are implied. This means that the statement

RATIO = TH/U;

will result in creation of a new variable RATIO with the value

$$\frac{\text{Value contained in the variable TH}}{\text{Value contained in the variable U}}$$

for each observation.

Among the programming options command-like instructions as
MERGE and UPDATE appear. These are of special interest in the
present case, since they allow the user to add new variables
(columns) and observations (rows) respectively to an existing
SAS data set. When a SAS data set is ready, more advanced cal-
culations can easily be carried out using the SAS procedures.
SAS procedures allow the user to print, sort, plot and statisti-
cally analyse the data. An impression of how easy SAS works is
given by the following example. Let's say we want a print-out
of an existing SAS data set. The statement

    PROC PRINT; DATA=KVANE;

will give the whole content of the data set KVANE well - for-
mated and with headings on each column. It should be noted,
that the boring job of writing output-formats has been elim-
inated, since SAS itself takes care of that.

On the IBM 3033 computer at NEUCC SAS can either be used in
batchjobs or interactively under TSO (Time Sharing Option).
SAS data sets are always used temporary but can also be stored
in a permanent file e.g. on disk or magnetic tape. A SAS
file is only to be read by SAS itself. The file contains in-
addition to the data set a directory with variable names, var-
able length etc.

If processing is to be carried out on the data with other type
of programmes (e.g. a plotting routine written in FORTRAN or
on other computers without the SAS system, the user must at
first transfer data from the SAS file to a formated file (e.g.
data sets, card images). This is easily by the PUT-command.
SAS is therefore to be considered a rather system dependent
database.

Finally the handling of missing values in SAS should be mention-
ed. When 'holes' in the data matrix exist, SAS represents these
by a decimal point. Thus the decimal point is the value of a
certain variable (not zero) and could be used directly. The
statement

```
IF ZIRCON- = . ;
```

finds all observations in the data set where an analytical
value of variable ZIRCON exists.

CREATION OF THE KVANE DATABASE

As shown in table 1 analytical results were obtained using up
to seven different types of analytical procedures. Each ana-
lytical result was supplied on punched cards or on card images
stored on magnetic tape. This data material together with start
coordinates for the 70 drill cores were placed in eight differ-
ent card files, comprising the input material for SAS. Since
the analytical work was carried out in different laboratories
there was neither consistency in the data nor in the way the
data were presented (notation and format) nor in the way of
identifying a sample. It was therefore necessary to read the
eight data files separately and create eight different SAS
data sets simultaneously. Later on these data sets were merged
together to make up the database KVANE (fig. 3). Each sample
was labelled with a sample number which in notation lies close
to those supplied by the laboratories. The notation used in
KVANE is defined by a numeric variable


```
PR_NR = DDMMM.CC
```


where DD is the drill hole number and MMM.CC is the distance
from the top of the drill hole to the point on the core where
the sample starts (meter system). A sample taken from 37.15
meters to 38.15 meters in drill hole 7 has accordingly the value
7037.15 assigned to the variable PR_NR.

In each of the eight input programmes an error facility was
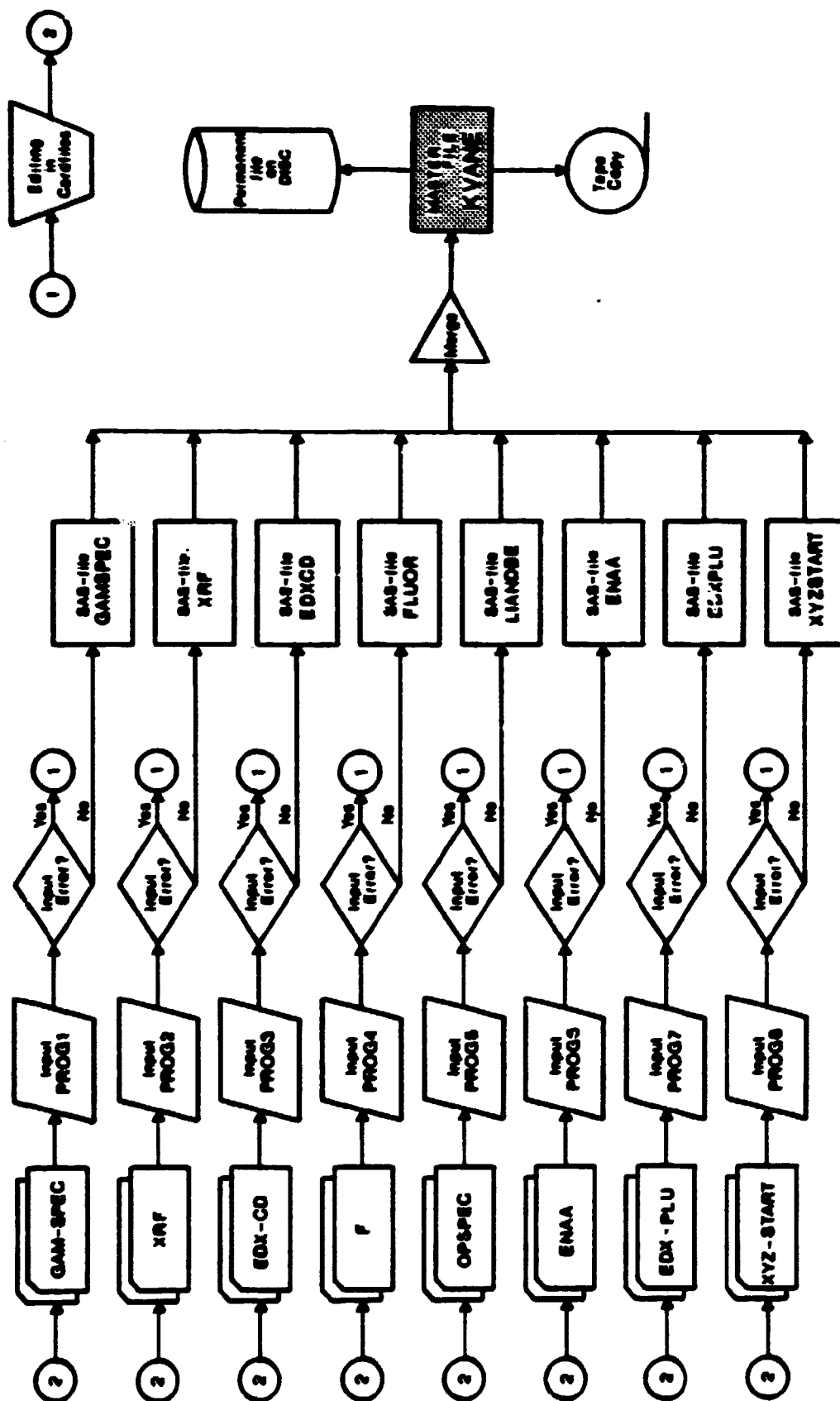built in. The necessity of this was clearly demonstrated when

Figure 3. Flow chart showing the main programming fases in the creation of the database KVANE.

two or more data cards contained one observation. When errors were found editing was made directly on the card file.

A self explanatory way of naming analytical variables was chosen. An analytical variable name has the following structure in KVANE

EL_UNIn,

·where EL is the element symbol, UNI the value unit (either PPM or PCT) and n the method index (see table 1). A variable representing an ENAA value of La given in ppm will accordingly be named LA_PPM6. In this way a discrimination between the same elements obtained from different analytical methods is possible.

In connection with the creation of the sub data sets of GAM-SPEC and XYZ-START (fig. 3) a number of geometric quantities was calculated. Since geostatistics deals with spatial distributed samples (Matheron, 1963), X, Y and 2 coordinates were calculated according to a local -X,Y coordinatesystem (fig. 4). The Z coordinate is simply the altitude of the sample above sea level. To get a proper X,Y system transformed coordinates were calculated by:

$$XTR = 1100 - X$$
$$YTR = Y + 1100$$
$$ZTR = Z$$

Among the rest of the variables included in KVANE the DIP and AZIMUTH of the drill holes, distance from drill hole starting point to either sample top or sample bottom and a three digit geology code should be mentioned.
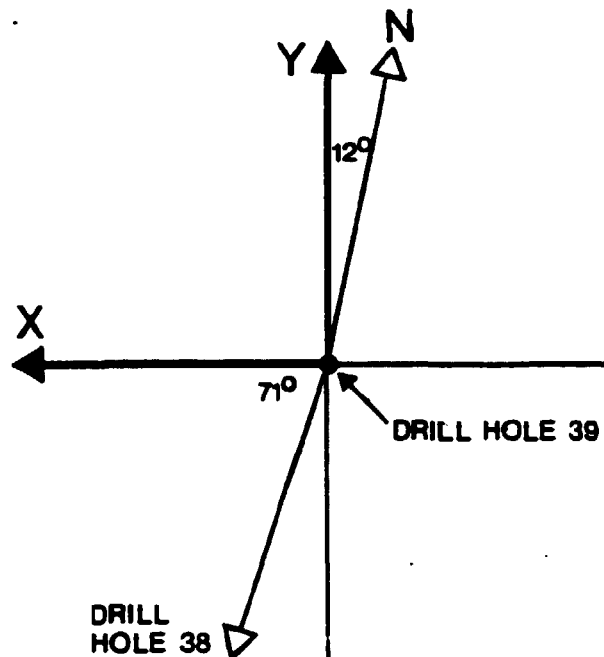
Figure 4. Orientation of the coordinate system in proportion to magnetic north and drill hole 39. (After Nyegaard et al., 1977).

HOW TO USE THE DATABASE KVANE

As shown in figure 3 the master file KVANE is stored both on a permanent disk and on magnetic tape (two copies). In periods where KVANE is not used, the disk file is deleted in order to save space for other purposes, but is easily recreated by copying back from one of the tape copies. Unfortunately this copying is necessary since SAS is unable to read directly in a SAS data set stored on magnetic tape.

All work with KVANE can as previously mentioned take place either interactively or in batch jobs. The way of operating is similar in the two cases. The interactive SAS is quite time-sharing and therefore more expensive than batch jobs. The latter are considered to be more safe.

When working with KVANE a temporary working data set which is
an exact copy of KVANE is created. This is done by the DATA/SET
command. The principle is then to reduce this working data set
to contain the data of interest by deleting observation and vari-
ables. This procedure is explained in the following two examples.
Comment-statements are indicated with a'*' in column one and
all statements are separated by a semicolon.

Example one.

Suppose a listing is required in a file A containing the ENAA
analyses for Fe, Co and Zn from drill core 59. Missing values
should be excluded, and the listing should be in a specified
format. The file A could either be on disc, card puncher or
on line printer. Finally simple statistics such as the mean and
variance are to be calculated.

```
 1: * WORKING DATA SET IS CREATED FROM KVANE;
 2:   DATA KVWORK 1; SET KVANE;
 3: * DRILL CORE 59 IS SELECTED;
 4:   IF BH=59;
 5: * THE DATA OF INTEREST ARE SELECTED;
 6:   KEEP PR_NR FE_PPM6 CO_PPM6 ZN_PPM6;
 7: * OBSERVATIONS WITH MISSING VALUES ARE DELECTED;
 8:   IF FE_PPM6 =. AND CO_PPM6 =. AND ZN_PPM6=.;
 9: * THE CONTENT OF KVWORK1 IS WRITTEN ON TO FILE A
10: * (HERE THE LINE PRINTER) IN A SPECIFIED FORMAT;
11:   FILE PRINT;
12:   PUT (PR_NR FE_PPM6 CO_PPM6 ZN_PPM6)(8.2 3*13.3);
13: * CALCULATE SIMPLE STATISTICS;
14: * THE WORKING DATA SET IS REPRODUCED FIRST;
15:   DATA STAT, SET KVWORK;
16:   PROC MEANS, N MEAN STD VAR;
```

Example 2

If we want to sort data according to topography, say, we want
to find the data points in a 100x100x50 meter large block with
the lower left corner placed in (XTR,YTR,ZTR)=(500.0,700.0, 500.0).
Besides the coordinates of the data points found in the block,
we need the sample number, the drill core number, the geology
code (GEOLOGY) and the uranium- and thorium values determined
by gamma-ray spectrometry. Output should be printed by descen-
ding ZTR value on a line printer disregarding formats. Using
the same notation as in example one we get:

```
 1: * WORKING DATA SET IS CREATED;
 2:    DATA KVWORK2; SET KVANE;
 3: * SELECT DATA POINTS ACCORDING TO TOPOGRAPHY;
 4:    IF XTR >=500.0 AND XTR <=600.0;
 5:    IF YTR >=700.0 AND YTR <=800.0;
 6:    IF ZTR >=500.0 AND ZTR <=550.0;
 7: * SELECTING THE VARIABLES NEEDED;
 8:    KEEP PR_NR BH GEOLOGY XTR YTR ZTR U_PPM1 TH_PPM1;
 9: * SORT THE DATA POINTS FOUND;
10:    PROC SORT, BY DESCENDING ZTR;
11: * PRINT OUT THE RESULT;
12:    PROC PRINT, BY BH;
```

UPDATING KVANE

New observations (analytical data on new samples) and variables
(e.g. further elements) can easily be added to the KVANE data-
base. This is done by UPDATE and MERGE commands. A SAS data set
containing the new data material is created and then merged
together with KVANE using either a BY variable (here PR_NR) or
variable names already contained in KVANE. Since the permanent
SAS data set contains a directory with variable names, SAS itself

ensures that the additional data go into the correct rows and
columns. The updating procedure could also be used for replacing
missing values in KVANE with real values.

Editing in the existing KVANE database is done using the EDITOR
procedure.

DISCUSSIONS AND CONCLUSION

It was found that the SAS system was suitable for creating a
database with drill core information from Kvanefjeld. Working
with KVANE and other similar databases created by using
SAS has shown, that the system is easy to operate even for users
with minimum of ADP knowledge.

The greatest disadvantage by using SAS in the present case is
the system dependency. KVANE has to be operated on a computer
with SAS facility available. However, the user could transfer a
limited number of data as formated records (e.g. card images)
to another computer without SAS, but should be aware of the space
expansion. It should also be mentioned that storing data as a
SAS data set requires more file space than necessary since space
is reserved for missing values. On the other hand, the file
space is small compared with data kept as card images.

ACKNOWLEDGEMENT

DANSK RESUME

I et forsøg på at samle alle borekerneinformationer hidrørende fra boreprogrammer udført på uranforekomsterne ved Kvanefjeldet i Sydvestgrønland, er en database betegnet som KVANE blevet udviklet. Til formålet benyttedes et anvendelsesprogrammel "Statistical Analysis System" (SAS), som sædvanligvis benyttes til statistiske programmeringsopgaver. Arbejdet har vist, at SAS, der arbejder uafhængigt af andre EDB-programmeller, er et udmærket stykke værktøj, når større datamængder skal lagres binært. Det er også vist, at adgangen til disse kan foregå uden ·større EDB-kendskab.

Artiklen giver en kort introduktion til SAS-systemet og beskriver dernæst, hvorledes KVANE er opbygget. Ved hjælp af to mindre programeksempler vises hvorledes specifikke data let udtages fra databasen, sorteres og overføres til yderligere behandling.

KVANE, der er implementeret på NEUCC, Danmarks tekniske Højskole, er systemafhængig og kan derfor ikke uden videre kopieres til et andet regneanlæg, med mindre dette besidder en SAS-facilitet.

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Abstract

A database KVANE containing all drill core information from the drilling programme carried out in 1958, 1962, 1969 and 1977 at the uranium deposit in Kvanefjeld, Southwest Greenland has been made. The application software "Statistical Analysis System (SAS)" was used as the programming tool. Its is shown how this software, usually used for other purposes, satisfy a demand of easy storing of larger data amounts. The paper describes how KVANE was made and organized and how data can be picked out of the database. A short introduction to the SAS system is also given.

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