
An Automated Method to Archive Wellbore Data

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Canadian Well Log Society (CWLS)
Metadata Committee
www.cwls.org

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1) Abstract

This paper describes a process that automates the archiving of wellbore data through the use of metadata. The technique is similar to that used by a public library, except that the metadata elements are specifically designed for wellbore data (See Appendix #1).

The proposed method can be applied immediately to “structured data”, such as LAS files, because software can be designed to extract information from the body of the file to populate the metadata element set. Software is unable to extract metadata information from the body of “unstructured data”, such as Adobe “pdf” files, and instead must rely on summary information tags to provide this information. This method only works if the metadata information was previously added to the summary information tag. For unstructured files, the process of adding a populated metadata element set to a tag is best done at the time the files are being created. This will require the service industry to make some changes to their operation.

This paper explains data storing concepts using metadata, defines a metadata element set for wellbore data, and shows its application to structured and unstructured data files. The focus is on wellbore data relating to logs and core. Logs, and possibly core, will benefit most from an industry standard because they are frequently accessed and exchanged between various parties. The method was successfully tested on a pilot project consisting of 26,425 LAS files.

2) Introduction

The concept proposed for organizing wellbore data uses techniques analogous to those of a public library. A public library collects basic information about each book using key words such as “title”, “author”, “publisher”, etc., transfers this information to a library reference card, and then organizes the reference cards so that they can be searched to retrieve the book.

In the computer world, electronic files are analogous to books. Electronic files generally reserve an area within their file structure for “summary information” where metadata can be stored. This space will be referred to as the “summary information tag”. The summary information tag is located under “file properties” and is, at present, rarely used by the oil industry.

Current nomenclature refers to key words (e.g., title, author, subject, date, etc.) as “metadata elements”, and a group of key words for a specific object (e.g., library book) as a “metadata element set”. The reference card becomes a “populated metadata element set”, that can be stored in the summary information tag (Figure #1), or programmatically extracted from structured files. The entire collection of library reference cards (i.e., populated metadata element sets) is stored in a reference database.

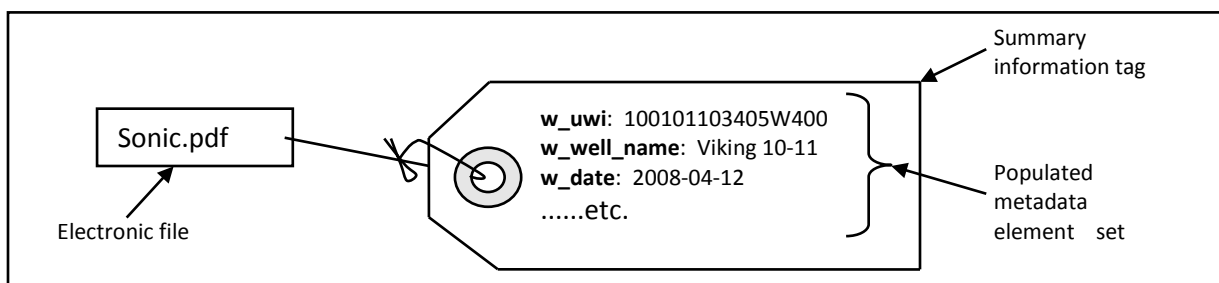


Figure #1: Conceptual illustration of a summary information tag.

3) The Metadata Element Set for Wellbore Data

A Metadata Element Set provides the elements by which data is organized. In a database, these become the items that are used to search and retrieve data.

The metadata element set proposed for wellbore data is shown in Figure #2. As can be seen, it consists of three main components: Organizational elements, Location/Well ID elements, and Descriptive elements. The Location/Well ID elements generally encompass the top half of a log header. The Descriptive elements mostly include information located on the bottom half of the log header. The Organizational elements of the metadata element set proposed for wellbore data are detailed in Figure #3.

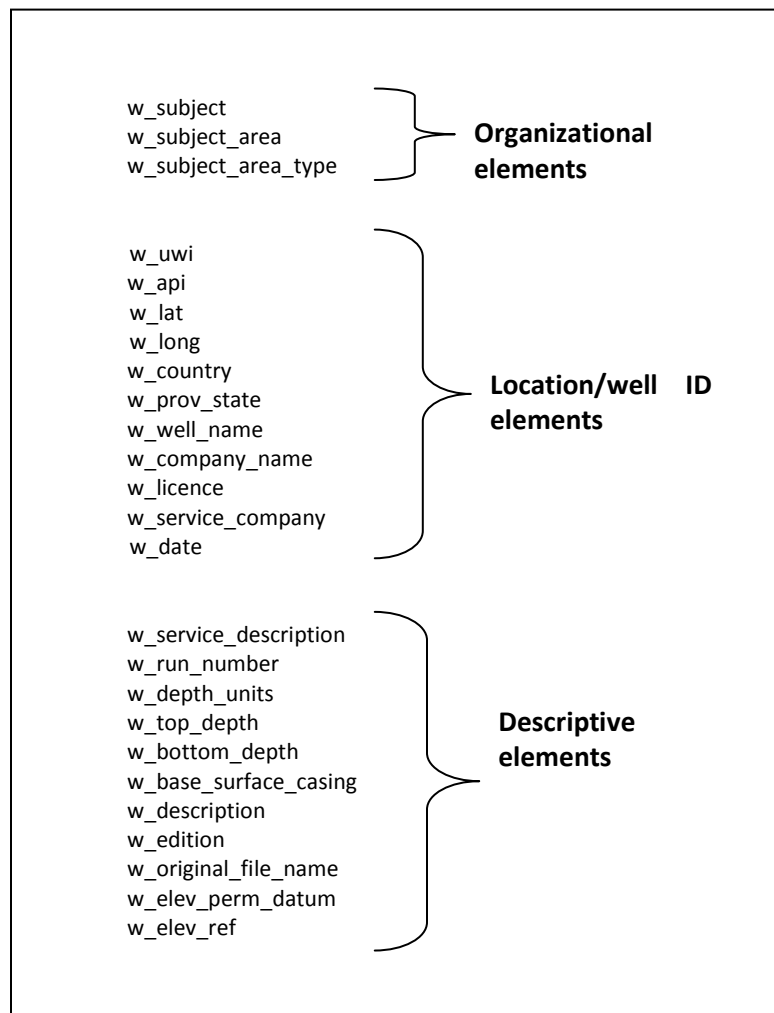


Figure #2: Metadata Element Set for Wellbore Data

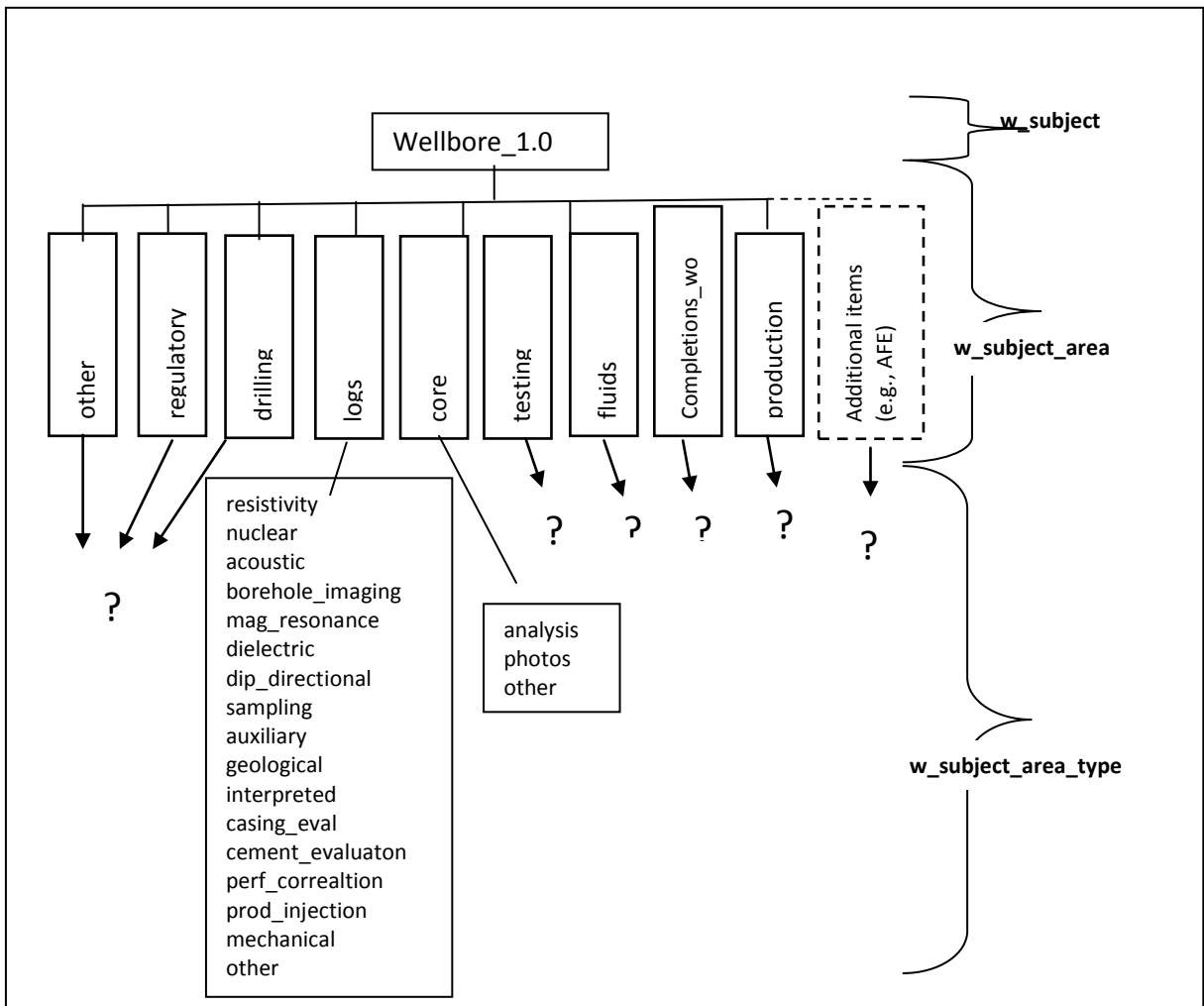


Figure #3: The organizational elements for wellbore data (the schema)

4) Principal Categories for Wellbore Data

As illustrated in Figure #3, the metadata element "**w_subject**" is Wellbore_1.0. It identifies the data as being wellbore data and indicates that this is version number 1.

The metadata element "**w_subject_area**" is subdivided into a number of categories. These categories represent the principal wellbore related activities common to resource exploration/exploitation:

- 1) Application for regulatory permissions
- 2) Drilling the well
- 3) Gathering log information
- 4) Gathering core information
- 5) Gathering well tests information
- 6) Gathering fluid analysis information
- 7) Completion, work over, and abandoning the well
- 8) Recording of production data

Additional categories may be added as needed (e.g., AFE, accounting, etc.). Note that the above list includes four categories for information gathering (items #3 through #6). This was done to minimize the number of

levels of data. The categories that will benefit most from an industry standard are logs, and possibly core (items #3 and #4), because these are frequently accessed and/or exchanged between parties. These two categories have been subdivided in the metadata element “**w_subject_area_type**” (Figure #3). The remaining categories for the metadata element “**w_subject_area**” have not yet been subdivided, because it is unclear if they require an industry standard.

5) Populating a Metadata Element Set

A populated metadata element set provides a summary of the contents of the electronic file. The means by which this information is obtained depends on whether the file is considered “structured” or “unstructured”.

Files are considered “structured” if software can extract information programmatically from the body of the file to populate the metadata element set. LAS files are considered “structured”. The populating of metadata element sets for structured data can be done programmatically.

Files are considered “unstructured” if software is unable to extract metadata information from the body of the file. An example of an “unstructured” file is an image file such as an Adobe Acrobat “pdf” file. The storing and searching of these files can only be automated if they include a summary information tag that contains a populated metadata element set (Figure #1). For unstructured files, the process of adding a populated metadata element set to a tag is best done at the time the files are being created.

6) Adding Metadata Information to Summary Information Tags

Summary information tags exist in some form on most electronic files, and were designed with the ability to store metadata information. For structured data, this tag is not needed because the metadata information can be extracted directly from files programmatically. As mentioned above, unstructured files require summary information tags containing metadata information. The process of adding metadata information to summary information tags of unstructured files is a manual process, and can only be automated during the creation of the unstructured files. This is not happening at present, but is seen as the direction of the future. It is hoped that this paper will motivate the industry that provides unstructured files to begin adding metadata information to the summary information tags.

There are several methods that can be used to add metadata information to the tags of unstructured files:

Dsofile.dll: The dsofile.dll dynamic link provided by Microsoft is capable of populating summary information tags onto a large variety of electronic files (pdf, doc, xls, ppt, txt, las, docx, xlsx, pptx, etc.). Unfortunately, for some file types, this information is removed when the electronic file is moved to another computer or to an external storage device. The exception is Microsoft Office 2007 files (docx, xlsx, pptx etc.)

Pdf Files: Adobe Acrobat provides a method to input custom metadata information to their summary information tag. This may require the purchase of Adobe Acrobat software.

Tiff Files: Metadata information can be added to these files. It is suggested that this information be added to tag 270 with the metadata elements being space delimited, and the metadata information being either space or comma delimited.

7) File Naming Convention for Archived Data (for Canada)

Archiving involves the collecting of summary information tags and their associated file names into a database. This metadata information can then be used to retrieve the desired files. To avoid overwriting issues, all file names must be unique. The suggested file naming convention (illustrated in Figure #4) is as follows:

- Begin the file name with the 16 character UWI to allow files to be sorted by UWI.
- Follow with a three character abbreviation for the **w_subject_area**
- Follow with a number of two character abbreviations for the **w_subject_area_type**.
- Follow with a unique reference number consisting of "yy_aaaaa" where "yy" refers to year and "aaaaa" refers to five alphanumeric characters resulting in a number to the base 36. This reference number will handle about 60,000,000 files annually. The underscore within the reference number may be replaced by a short version of the company name (e.g., BP, SLB, UAE).
- Follow with an extension to indicate the file type.

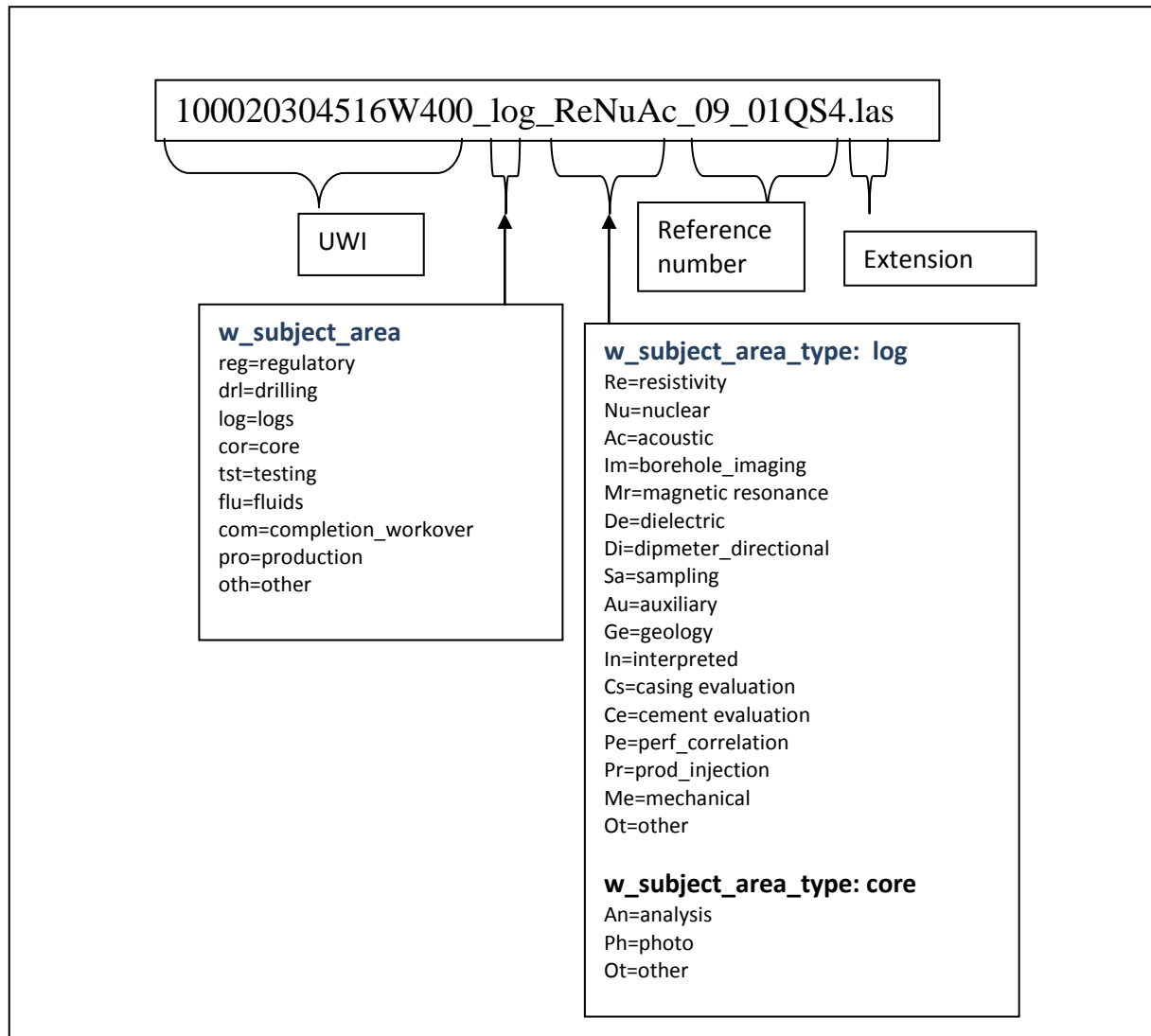


Figure #4: Suggested file naming convention

8) Testing the Concept

Three initial tests of the proposed archival method were run. The first test used a dataset of 147 LAS files from 43 wells, with the objective of identifying missing log data. It succeeded. A second test consisted of one well consisting of 57 files of a varied nature (LAS, txt, jpg, DLIS, htm, PDS, rtf, and tiff) to test the schema for all types wellbore information. It also succeeded. The positive results provided enthusiasm for a more formal and much larger pilot project, which consisted of about 26,425 LAS files from 4,688 wells. The results of this test were reviewed by a geological group, who identified some important shortcomings. The model was then revised, and the complete test rerun. The results were impressive:

- Archiving and retrieving logs was fully automated.
- Wells that did not comply with government regulations relating to log data submissions were clearly identified.
- The processing time on an old laptop computer was less than two days.

The archival process used in the pilot project is illustrated in Figure #5.

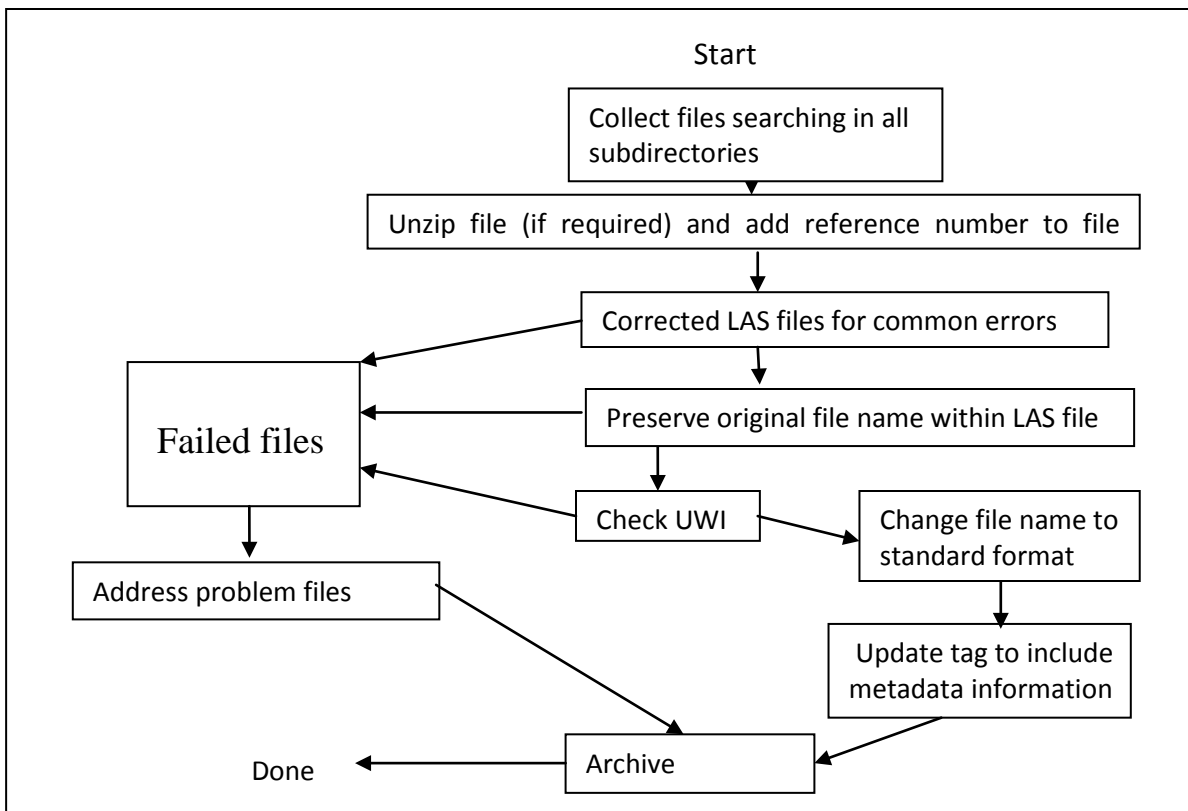


Figure #5: Archival process used in pilot project.

9) Determining **w_subject_area_type** for LAS Files

Existing LAS files specify log curve names, but not the **w_subject_area_type** as defined in this paper. In the future, the service industry may wish to consider providing this information on a separate line within the LAS file of the form:

SubjectAreaType. ReNuAc : resistivity nuclear acoustic
 or
SubjectAreaType. resistivity nuclear acoustic : resistivity nuclear acoustic

In the meantime, this information can be obtained through the use of a lookup table that associates log curve mnemonics to **w_subject_area_type**. Such a lookup table was designed for testing purposes and is displayed in Figure #6. This table does not need to include all existing curve mnemonics (over 140,000 exist), but does need to include all of the defined **w_subject_area_types** for logs. The table is kept to a manageable length by including only the principal curve mnemonics.

As an example, the principal measurement for the **w_subject_area_type** of "acoustic" is the interval transit time, which is normally found under one of the mnemonics DT34, DT35, DTCA, AC, DT, DTC, DTL, DTLF, DTLN, TR21, TR22, DT1, DT2, DT24, DT4P, or DTRP.

Note that Figure #6 includes auxiliary measurements (**w_subject_area_type** = "auxiliary"). Circumstances may arise in which the principal measurement is one that is more frequently recognized as an auxiliary measurement. An example of such a situation is when the total logging operation consists of only a caliper log. Figure #6 is considered a starting point and may be missing some important items. It is therefore up to the individual user to modify this table as required.

w_subject_area_type	Associated curve mnemonics
resistivity	LL, LN, FE, FE2, FR, IL, RILD, RESD, RIPD, ILD, RLLD, HLLD, LLD, M2R6, M2R9, AF60, AHF60, AHT60, AIT60, AT60, IDPH, AF90, AHF90, AT90, RLA5, DVR2, MVR2, SFLR, DVR2, AHT90, AO90, AHO90, 20KD, RILM, RIPM, ILM, AIT30, MVR2, M2R3, IMPH, AF30, AHF30, AHT30, AO30, AT30, RLA3, 20KM, RLLS, RSFL, PSHG, RSG, FE1, RILS, RESS, LLS, HLLS, FEFE, RLL3, LL3, LL8, HLLS, HLLD, SN, M2R2, SFL, SFLU, AF20, AHF20, AHT20, AO20, AIT20, AT20, RLA2, SFLR, CILD, RES(DG), RES(SG)
nuclear	CODE, ZDEN, DEN, DNC, HRHD, ZRHD, RHOB, RHO8, RHOZ, DPRS, DPHI, DPHZ, PORZ, DPHI_SAN, DPSS, PDS, DEPO, DCOR, DECR, EDRH, POS, CNCS, CNCSS, TNPH_S, RPOR, NPOR, NPFI, NPRS, NPSS, NPOR_SAN, NPOR_LIM, TNPH_SA, TNPH_SAN, NPFI_SAN, TNPH_LIM, NPFI_LIM, NPFI_S, TNPH_S, CNC_S, NPFI_L, TNPH_L, CNC_L, NPLS, SNP, DEN(SS), DEN(LS), DPDL, PEF, NPDL, POR(DEN), POR(NEU), NPFI_DOL, TNPH_DOL, HNPO
acoustic	DT34 DT35 DTCA AC DT DTC DTL DTLF DTLN TR21 TR22 DT1 DT2 DT24 DT4P DTRP
interpreted	SW, PHIE, VSH
sampling	BQP1, BQT1, BSG1
prod_injection	WTEP SPIN WPRE
dip_directional	HAZI, RB, SDEV, DEVI, GDEV, AZIM, DIR, DIP
auxiliary	GR, GRA, GRI, GRD4, GRGM, GAM, GRNP, GRDE, GRPD, GRIN, GRSD, GRDI, GRGC, HGR, CGR, CAL, CALI, SP, CALIPER1, CALIPER2, C1, C2, HCAL, CAL2, CALS, SPCG, PCH1, SPI3
core	VSH_PCC

Figure #6: Lookup table relating curve mnemonics to w_subject_area_type

10) Examples from the Pilot Project

Figures # 7 and # 8 are sample images from the database created by the 26,425 file pilot project. The following items from these figures are noteworthy:

- All file names begin with the UWI. Using the UWI simplifies grouping the data.
- All file names identify their contents in a general manner. The first file in Figure #7 for example, represents a log of the types resistivity, nuclear, and acoustic ("ReNuAc"). The file extension indicates that this is an LAS file.
- For each file in Figure #7, the top, bottom and casing depths are noted in columns 2, 3, 4 respectively. This information, in conjunction with the curve names, suggests a neutron and gamma ray logs exist over the surface casing interval.
- Note the unique file reference numbers located before the file extensions in both figures (e.g., "09_00JP2" for the first file in Figure #7).
- Figure #8 identifies the curve names within a number of LAS files.

File Name	Top depth	Bottom depth	Casing shoe
1000715001xxW400_log_ReNuAc_09_00JP2.LAS	1235	1339.5	226.7
1000715001xxW400_log_ReNuAc_09_00JP7.LAS	10	1339.5	226.7
10014060yy05W400_log_ReNu_09_00GR9.las	5.5	652	148.6
10014060yy05W400_log_ReNu_09_00GRA.las	555.9	652	148.6
10014060yy05W400_log_ReNu_09_00GRB.las	5.5	602.5	148.6
10014060yy05W400_log_ReNu_09_00GTE.las	555.9	652	148.6
10014060yy05W400_log_ReNu_09_00K45.las	5.5	652	148.6
10015060zz05W400_log_ReNu_09_00H30.las	3.8	637.5	158.5
10015060zz05W400_log_ReNu_09_00H31.las	559.1	637.5	158.5
10015060zz05W400_log_ReNu_09_00H32.las	3.7	610	158.5
10001120xx06W400_log_ReNuAc_09_00GCS.LAS	466.8	576.8	131.6
10001120xx06W400_log_ReNuAc_09_00GFH.LAS	0	575.7	131.6
10001120xx06W400_log_ReNuAc_09_00K4W.LAS	0	575.7	131.6

Figure #7: A sample image from pilot project wells illustrating file names, depth intervals they represent, and the depth of the surface casing shoe.

File Name	Curve Mnemonics (found under metadata element "w_description")
• 10001010xx05W400_log_Nu_09_00DDH.LAS	• DEPT,GR,NPOR,TNPH,CFTC,CNTC,CCL
• 10001010xx03W400_log_NuDi_09_00E8J.LAS	• DEPT,AHMF,GDEV,HCAL,HDPH_DOL,HDPH_LIM,HDPH_SAN,HDRA,HGR,HTEM,HTNP_DOL,HTNP_LIM,HTNP_SAN,PEF8,RHO8,TENS
• 10001010xx03W400_log_NuDi_09_00E8M.LAS	• DEPT,AHMF,GDEV,GR,HTEM,TENS,TNPH_DOL,TNPH_LIM,TNPH_SAN
• 10001010xx03W400_log_ReNuAcDi_09_00E8.LAS	• DEPT,AHF10,AHF20,AHF30,AHF60,AHF90,AHF60,AHF90,AHF60,AHFCO60,AHMF,GDEV,GR,HTEM,RXOZ,SP,TENS,DPHI_DOL,DPHI_LIM,DPHI_SAN,HCAL,HDRA,PEFSA,RHOZ,TNPH_DOL,TNPH_LIM,TNPH_SAN,DT,TT1,TT2,TT3,TT4
• 10001010xx03W400_log_ReNuAcDi_09_00E8.LAS	• DEPT,AHF10,AHF20,AHF30,AHF60,AHF90,AHF60,AHF90,AHF60,AHFCO60,AHMF,GDEV,GR,HTEM,RXOZ,SP,TENS,DPHI_DOL,DPHI_LIM,DPHI_SAN,HCAL,HDRA,PEFSA,RHOZ,TNPH_DOL,TNPH_LIM,TNPH_SAN,DT,TT1,TT2,TT3,TT4
• 10001010xx23W400_log_Pr_09_00B2F.LAS	• DEPT,TENS,SPIN,SCVL,GR,WTEP,WPRE,MWFD,CCLD

Figure #8: A sample image from the pilot project wells illustrating file names and the names of the curve mnemonics.

11) Example Search Capabilities

11.1) Identify wells with sonic logs for a specific area:

- An area will be bounded by latitude and longitude coordinates. These can be related to UWIs such that the wells within that area can be identified.
- Search the above list for files with **w_subject_area** = "logs"
- Search the above results for files with **w_subject_area_type** = "acoustic"

11.2) Determining if well 'X' has an "SP" over a specific interval:

- Search the database for files with UWI = "X"
- Search the above results for files with **w_subject_area** = "logs"
- Search the above results for files with **w_subject_area_type** = "Resistivity"
- Search the above results for files with **w_description** containing a curve mnemonic for SP curve using a lookup table.
- Search the above results for files with data in **w_depth_units**, **w_top_depth**, **w_bottom_depth** and **w_base_surface_casing** to determine the intervals over which the SP log exists.

11.3) Identifying wells in area 'A' with porosity logs:

- Search the database for wells with UWIs within area 'A' (as per description in item #11.1)
- Search the above results for files where **w_subject_area** = "logs"
- Search the above results for files where **w_subject_area_type** = "acoustic" or "nuclear"

11.4) Identifying wells in area 'A' with neutron and density logs newer than 1974:

- Search the database for wells with UWIs within area 'A' (as per description in item #11.1)
- Search the above results for files where **w_subject_area** = "logs"

- Search the above results for files where **w_subject_area_type** = "nuclear"
- Search the above results for files where **w_description** contains curve mnemonic for "density" with the help of a lookup table (Figure #6)
- Search the above results for files where **w_description** contains curve mnemonic for "compensated neutron" with the help of a lookup table (Figure #6).
- Search the above results for files where "**w_date**" > 1974

11.5) Identifying wells in area 'A' with high resolution porosity logs in LAS format:

- Search the database for wells with UWIs within area 'A' (as per description in item #1)
- Search the above results for files where **w_subject_area** = "logs"
- Search the above results for files where **w_subject_area_type** = "acoustic" or "nuclear"
- Search the above results for files with the extension of "las"
- Search the above results for files where **w_original_file_name** the string "HiRes" or "H" or "HR".

12) Conclusions

A method was proposed for automating the archival process for log and core data through the use of a metadata element set. The method was successfully tested on a data set of 26,425 LAS files.

The concept introduced in this paper can be adopted immediately for structured data, but will require some changes from the service industry before it can be applied efficiently to unstructured data. The motivators to do so are as follows:

- Regulatory bodies will be able to accept electronic submissions if unstructured files include metadata information in their tags. The benefits to the regulatory bodies are: 1) a reduction of paper submissions, 2) a decrease in handling and storage costs, 3) improved ability to monitor compliance to well data submission regulations, 4) easier distribution of non-confidential data to industry.
- Resource companies will have better access to wellbore data.
- Wireline companies will experience a notable reduction in the number of paper logs generated for their clients. It will also improve their ability to track and archive wellbore data.

The use of metadata information is seen as a method that will significantly increase the efficiency of archiving electronic files. Log and core data are exchanged extensively between companies and will therefore benefit most from the standard metadata element set for wellbore data that is described in this paper. The implementation will require support and cooperation of many sectors of the oil industry. The resulting benefits will be worth the effort.

13) References

- TIFF revision #6 Final – June 3, 1992;
<http://partners.adobe.com/public/developers/en/tiff/TIFF6.pdf>
- Dublin Core Metadata Initiative; www.dublincore.org
- Metadata Standards and Metadata Registries: An Overview by Bruce E. Bargmeyer, Environmental Protection Agency, and Daniel W. Gillman, Bureau of Labor Statistics, Daniel W. Gillman, Bureau of Labor Statistics, Washington, DC 20212 gillman_d@bls.gov

Appendix #1 (April 30, 2010)

Wellbore_1.0: A Metadata Element Set for Wellbore Data

This section introduces the metadata element set proposed for wellbore data. All metadata elements have the prefix “w_” to make them instantly identifiable as metadata elements for wellbore data. The components that are fully developed are the **w_subject_area** “log” and “core”. The other subject areas have not been fully defined. Each metadata element is classified as “mandatory” or “optional”. An element is classified as ‘mandatory’ if the data has zero value without this element.

The metadata elements for wellbore data are as follows:

w_subject

(Mandatory) For wellbore data, the subject is “wellbore_1.0”. The “1.0” component refers to the version number and will allow versions to be identified.

w_subject_area

(Mandatory) The categories are defined as follows.

1. “**regulatory**” – all regulatory items
2. “**drilling**” – all related drilling data prior to rig release
3. “**log**” – all measurements or descriptions made within the borehole.
4. “**core**” – description, analysis, photo
5. “**testing**” – drill stem test data
6. “**fluids**” – all fluid analyses
7. “**completion_workover**” – completion and workover information
8. “**production**” – all production related information
9. “**other**” – unclassified well data

w_subject_area_type

(Optional) This is a subdivision of the subject area. The **w_subject area type** has been fully defined for “log” and “core”. The **w_subject area types** for other **w_subject_areas** have not been defined.

Subject Area Types for Logs

Logs are classified by the generic name of their principal measurement.

- “**resistivity**” (e.g., E-log, induction, lateral, microlog)
- “**nuclear**” (e.g., neutron, density, pulsed neutron)
- “**acoustic**” (e.g., sonic, shear sonic, dipole sonic, VSP, waveform)
- “**borehole_imaging**” (e.g., resistivity, acoustic, video)
- “**mag_resonance**” - magnetic resonance
- “**dielectric**”
- “**dip_directional**” (dipmeter and directional data)
- “**sampling**” (e.g., fluid sampler, sidewall cores, pressure)
- “**auxiliary**” (e.g., SP, gamma ray, caliper)

- “**geological**” (e.g., mud logs, strip logs)
- “**interpreted**” (e.g. Volan, Coriband, etc.)
- “**casing_eval**” (e.g., corrosion logs, casing inspection logs, multi finger caliper)
- “**cement_eval**” (e.g., cement bond logs, cement top log)
- “**perf_correlation**” (e.g., perforating records, collar logs, depth control logs, tubing conveyed records, collar locator logs)
- “**prod_injection**” (e.g., flow meter, temperature logs, fluid level, tracer logs, noise logs)
- “**mechanical**” (e.g., dump bailer, gravel pack related, tubing cutter, pipe analysis log, packer setting tool, plug related)
- “**other**” - unclassified items (e.g., logging program, log related transmittal reports, etc.)

Subject Area Types for Core

- “**analysis**” – the results
- “**photos**”- core photos
- “**other**” – unclassified items (e.g., core transport report, core analysis request form)

w_uwi

(Mandatory) Unique well identifier; Canadian UWIs must be a 16 character string. Please eliminate all dashes, slashes, and spaces. For countries without a formal UWI, the following metadata elements may be more appropriate:

w_api

(Mandatory if applicable) API code used in the USA for identifying a well

w_lat

(Mandatory if API or UWI is not used) Latitude

w_long

(Mandatory if API or UWI is not used) Longitude

w_country

(May be required for clarity) Country

w_company_name

(Optional) Company Name

w_well_name

(Optional) Well name.

w_prov_state

(Optional) province or state

w_licence

(Optional) Licence number issued by a government regulatory agency. This element is intended for log data (LAS and image files) and may not be applicable to all categories under **w_subject_area**.

w_date

(Optional) The date refers to when the data was captured or created. The preferred format is of the form "yyyy/mm/dd" or "yyyy-mm-dd"

w_service_company

(Optional) Service company name.

w_service_description

(Optional) This refers to the name of service as defined by the service provider (e.g., "Dual Induction", "Compensated Densilog", etc.)

w_run_number

(Optional) The run number as defined by the service company.

w_depth_units

(Mandatory) All responses will be accepted. The more common responses will be "m" for metres and "f" for feet.

w_top_depth

(Optional) The top depth (or only depth) associated with the data. This element may not be relevant to all wellbore data.

w_bottom_depth

(Optional) The bottom depth associated with the data. If the data has only one depth (as in the case of cement top log) this may be left blank.

w_base_surface_casing

(Optional) This refers to the depth of the surface casing shoe. It is applicable only where the subject area is 'log' and is included to address a government need.

w_description

(Optional) This section is for a more detailed description of the "w_subject_area_type". For logs this may include curve mnemonics delimited by a comma. For core analysis this may include the type of analysis (e.g. routine, special, thin section, XRD, etc.)

w_edition

(Optional) This allows the edition of the file to be documented. The more common entries are expected to be of the form "field", "final", "corrected June 2009", etc. It is expected that this entry will often be left blank.

w_original_file_name

(Optional) Knowledge of the original file name may prove informative. The file name for structured files (e.g. DLIS, LAS files etc.) will preferably include whether the file represents the main, repeat, high resolution and/or TVD pass (e.g. xxxMain.las, xxxRPT.las, xxxHiResTVD.las, etc.).

w_elev_perm_datum

(Optional) Elevation of permanent datum.

w_elev_ref

(Optional) Elevation of reference.