Oil and Gas database management in China

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TOPICS

◆ Background of Oil & Gas activity in China
◆ Standard & metadata structure
◆ Recommendations
TOPIC --- Background of Oil & Gas activity in China

- Petroleum legislation
- Data Management Policy & Strategy
- Organizations
- Evolution of petroleum database management
<table>
<thead>
<tr>
<th>Current Major Mineral Resources Laws (MRL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative items of Constitution and Criminal Law of China (宪法和刑法)</td>
</tr>
<tr>
<td>Mineral Resources Law of P. R. China (1996, Amendments) (矿法)</td>
</tr>
<tr>
<td>Regulations for Registering to Explore for Mineral Resources Using the Block System (Promulgated on Feb. 12, 1998) (区块办法)</td>
</tr>
<tr>
<td>Regulations for Registering to Mine Mineral Resources (Promulgated on Feb. 12, 1998) (采矿办法)</td>
</tr>
<tr>
<td>Regulations for Transferring Exploration and Mining Rights (Promulgated on Feb. 12, 1998) (转让办法)</td>
</tr>
<tr>
<td>Regulations of the People’s Republic of China on the mining of Offshore Petroleum Resources in Cooperation with Foreign Enterprises (Promulgated in 2001) (海上对外合作条例)</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>Administration Provisions Concerning the Payment of Compensation for Mineral Resources in China (Promulgated in 1994) (补偿费管理办法)</td>
</tr>
<tr>
<td>Interim Provisions Concerning the Payment of Resources Tax in China (Promulgated in 1993) (资源税)</td>
</tr>
<tr>
<td>Regulations on Administration of Geological Data (Promulgated in 2002) (地质资料汇交)</td>
</tr>
<tr>
<td>Other laws, regulations, rules and criterion documents related to the mineral resources.</td>
</tr>
</tbody>
</table>
Registration for exploration

Exploration licenses. The licensee have an exploration right to explore for oil and gas in the approved region. Exploration rights are the right of exploring for mineral resources such as oil and gas in approved area.

Registration for mining

Mining licenses The licensee have an mining right to mine oil and gas in the approved region. Mining rights are the right of mining mineral resources such as oil and gas in approved area.

Using the application method to issue an oil & gas license:
10 steps

A: Accepting
B: First-examine
C: Re-examine
D: Auditing
E: Co-auditing with related departments of MLR
F: Make a joint checkup and signed by the deputy minister of MLR
G: Issue the exploration or mining license
H: Collect the exploration or mining fee of the first year
I: Put on records
J: Bulletin
(1) Regulations on Administration of Geological Data
(Promulgated in 2002)

This regulation prescribes the content of geological data, request exploration and mining licensees to hand in geological data in certain period.

(2) Combination of “Government administration” and “Enterprise administration”

1> Set special departments both in State and Provinces to manage geological data
2> Set geological data center in enterprises
They issue and manage oil and gas mining rights.
According to the laws and regulations, the main four oil and gas companies approved by the State Council to explore and mine oil and gas in China are CNPC (PetroChina), SINOPEC, CNOOC and Shaanxi Yanchang oil company.
Main business

- Exploration, development and production of crude oil and natural gas;
- Refining, transportation, storage and marketing, including import and export of crude oil and petroleum products;
- Production and sale of chemical products;
- Transmission, marketing and sale of natural gas.
Evolution of petroleum database Management

Early Stage : 1990-2003

1. published the earliest oil & gas database standard.
2. invested in technique study and training.
3. encouraged branches to construct E&P database according to the standard.

- During the past ten years, almost every oilfield of SINOPEC has established their E&P database to manage data and provide services for research and administration.
Current Status: after 2003

Along with the rapid development of IT, the whole data management project was optimized according to new requirements.

1. Analyzed the data model in petroleum industry
2. Updated standard of data management
3. Tried to design a unified data management platform, to integrate the E&P database, and to enhance the Multi-Disciplinary Data Sharing
TOPICS

◆ Background of Oil & Gas activity in China
◆ Standard & metadata structure
◆ Recommendations
TOPIC --- Standard & metadata structure

- Metadata design & structure
- International standard used
- System & technologies used
- Data flow & access
- Challenges to national database management
- Future plans to improve database management
Many kinds of data need to be managed:

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Content</th>
<th>Store Method</th>
<th>location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural data</td>
<td>data</td>
<td>database</td>
<td>Oracle</td>
</tr>
<tr>
<td></td>
<td>metadata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonstructural data</td>
<td>Document, Picture, Bulk data, drill core</td>
<td>CD, tape, film, paper</td>
<td>Shelf</td>
</tr>
<tr>
<td></td>
<td>data</td>
<td>tape</td>
<td>ATM, shelf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Digital file</td>
<td>Hard disk</td>
</tr>
<tr>
<td></td>
<td>metadata</td>
<td>table</td>
<td>Oracle</td>
</tr>
<tr>
<td>GIS data</td>
<td>Usually used data</td>
<td>database</td>
<td>Oracle Spatial</td>
</tr>
<tr>
<td></td>
<td>metadata</td>
<td>database</td>
<td>Oracle</td>
</tr>
<tr>
<td>Unusually used</td>
<td>data</td>
<td>Digital file</td>
<td>Hard disk</td>
</tr>
<tr>
<td></td>
<td>metadata</td>
<td>database</td>
<td>Oracle</td>
</tr>
</tbody>
</table>
We have ranged them into three groups:

1. E&P data
2. GIS data
3. Archival data

- Geological archival data
- Multi-media data
- Books & periodicals
- Other un-structured data

- Wellbore data
- Bulk data
- Production data
- Facilities data

- POSC EPICENTRE

- GIS data
- Basin data
- Geological map
- Image data, etc.

- ISO 19115

- Dublin Core
E&P metadata design

We analyze the 

POSC EPICENTRE
Meta Model

35 logical entities of the metadata to describe how a logical data model was projected to create the corresponding Relational Implementation.

Abbreviation: 
att_col_grp_map
attribute
change
change_request
changed_object
column_def
column_group
ddl_tuning
description
diagram_set
duplication
delivery
definition
enum_type
enum_value
epic_type
obj_desc
prod_versn
projection_map
ref_column_grp
ref_dupl_method
ref_feature
ref_object
ref_proj_method
ref_rule_type
ref_schema
rules
schema_def
select_type
source
sql_type
supersub
table_def
type_def
use_stats
We design our E&P database metadata based on POSC Epicentre Metadata model

<table>
<thead>
<tr>
<th>number</th>
<th>ChineseName</th>
<th>EnglishName</th>
<th>describe</th>
<th>type</th>
<th>length</th>
<th>Is Key</th>
<th>Not</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>表名</td>
<td>Tablename</td>
<td></td>
<td>Char</td>
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<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>变化字段名</td>
<td>ColumnName</td>
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<td>char</td>
<td>20</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>变化类型</td>
<td>ChangeType</td>
<td>Insert, delete, update</td>
<td>Char</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>变前长度</td>
<td>LengthBeforeChange</td>
<td></td>
<td>Char</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>变后长度</td>
<td>LengthAfterChange</td>
<td></td>
<td>Char</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>变前类型</td>
<td>TypeBeforeChange</td>
<td></td>
<td>Char</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>变后类型</td>
<td>TypeAfterChange</td>
<td></td>
<td>Char</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>变前是否允许空</td>
<td>NullBeforeChange</td>
<td></td>
<td>Char</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>变后是否允许空</td>
<td>NullAfterChange</td>
<td></td>
<td>char</td>
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<td></td>
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<td>Char</td>
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<td>Y</td>
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<tr>
<td>11</td>
<td>改变人</td>
<td>ChangeDBA</td>
<td></td>
<td>Char</td>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A subset of metadata: metadata about data table
<table>
<thead>
<tr>
<th>number</th>
<th>Chinese Name</th>
<th>EnglishName</th>
<th>describe</th>
<th>type</th>
<th>length</th>
<th>Is Key</th>
<th>Not</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>关系名</td>
<td>RelationCaption</td>
<td>Relation name</td>
<td>Char</td>
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<td>Y</td>
<td>Y</td>
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<tr>
<td>2</td>
<td>涉及表名</td>
<td>RelatedTableName</td>
<td>Table name involved</td>
<td>Char</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>关系表达式</td>
<td>RelationExpression</td>
<td>Relation express</td>
<td>Char</td>
<td>200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>number</th>
<th>Chinese Name</th>
<th>EnglishName</th>
<th>describe</th>
<th>type</th>
<th>length</th>
<th>Is Key</th>
<th>Not</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>表名</td>
<td>TableName</td>
<td></td>
<td>Char</td>
<td>50</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>序号</td>
<td>ColumnNumberInTabe</td>
<td></td>
<td>Char</td>
<td>5</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>字段名</td>
<td>ColumnName</td>
<td></td>
<td>Char</td>
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<td>Y</td>
<td>Y</td>
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<tr>
<td>4</td>
<td>字段标题</td>
<td>ColumnCaption</td>
<td></td>
<td>Char</td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>类型</td>
<td>ColumnType</td>
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<td>Char</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>长度</td>
<td>ColumnLength</td>
<td></td>
<td>Char</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>是否关键字</td>
<td>ISKey **</td>
<td></td>
<td>Char</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>是否允许空</td>
<td>IsNull</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The subset of metadata help us to monitor the data table
GIS metadata design (ISO 19115)

GIS metadata involves kinds of geology object and related data type. This is a concept diagram of GIS metadata structure. Every metadata includes one or more entities and elements.

We apply ISO 19115 to design our GIS metadata.
## GIS metadata design

<table>
<thead>
<tr>
<th>sequence number</th>
<th>EntityName</th>
<th>Element name</th>
<th>Element name</th>
<th>English abbr.</th>
<th>Definition</th>
<th>Constraint</th>
<th>Present times</th>
<th>Data type</th>
<th>Value region</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1</td>
<td>MD_metadata</td>
<td>MD_Metadata</td>
<td>Metadata</td>
<td>Root entity to define certain data setor data source</td>
<td>M</td>
<td>1</td>
<td>Class</td>
<td>1.1.1-1.1.11</td>
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<tr>
<td>1.1.2</td>
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<td>metadataTitle</td>
<td>mdTitle</td>
<td>title</td>
<td>O</td>
<td>1</td>
<td>String, text</td>
<td>CCYY-MM-DD GB/T 7408-1994</td>
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<tr>
<td>1.1.3</td>
<td></td>
<td>language</td>
<td>mdLang</td>
<td>language</td>
<td>O</td>
<td>N</td>
<td>String, Chinese, English</td>
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<tr>
<td>1.1.4</td>
<td></td>
<td>characterSet</td>
<td>mdChar</td>
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<td>O</td>
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<td>Class, MD_character_set_A.1</td>
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<tr>
<td>1.1.5</td>
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<td>mdStanName</td>
<td>Standard used</td>
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<td>1</td>
<td>String, text</td>
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</tr>
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<td>1.1.6</td>
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<td>metaDataStandardVersion</td>
<td>mdStanVer</td>
<td>Version number of Standard used</td>
<td>O</td>
<td>1</td>
<td>String, text</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.7</td>
<td></td>
<td>contact</td>
<td>mdContact</td>
<td>Department or person with responsibility for metadata</td>
<td>M</td>
<td>N</td>
<td>Class, CI_Principal department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.8</td>
<td></td>
<td>identificationInfo</td>
<td>dataIdInfo</td>
<td>Basis info to describe geological dataset</td>
<td>M</td>
<td>1</td>
<td>Class, MD_identity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.9</td>
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<td>dataQualityInfo</td>
<td>dqInfo</td>
<td>Evaluate of data quality</td>
<td>M</td>
<td>1</td>
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<td></td>
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<td>1.1.10</td>
<td></td>
<td>referenceSystemInfo</td>
<td>refSysInfo</td>
<td>spatial reference system of metadata</td>
<td>C</td>
<td>1</td>
<td>Class, RS_spatial_reference_system</td>
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</tr>
<tr>
<td>1.1.11</td>
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<td>conInfo</td>
<td>Content of metadata</td>
<td>M</td>
<td>N</td>
<td>Class, MD_content_description</td>
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<td>1.1.12</td>
<td></td>
<td>distributionInfo</td>
<td>distInfo</td>
<td>Info about distribute or method to retrieve the product info</td>
<td>O</td>
<td>1</td>
<td>Class, MD_distribute</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This is our metadata table.
Case system-
Geology and Geography database of SINOPEC
An archival file includes all the data built during the whole E&P process of a well, a survey, or a research project.

This figure shows the parts of archival file:
- **Archival File**
- **Archival Catalog**
- **Archival Asset** (All kinds of data, Media (Paper, tape), digital file)

- **Well**
- **Survey**
- **Project**
Archival metadata design

The metadata help us to describe the archival data
Archival metadata design

### Archival Security
- Archival Code
- InFileNumber
- NewArchivalCode
- SecurityThings
- NewSecurityLevel
- ProtectPeriod
- StartDate
- OldSecurity
- SecurityType
- IsProtectedByEnterprise
- SecurityPage
- PictureNumber
- LevelScale
- VerticalScale

### Archival Protection
- ProtectionRegisterNumber
- GatherDataListNumber
- InListNumber
- DataName
- ProtectType
- ProtectStartDate
- ProtectEndDate
- ProtectApplyDate
- RegisterDate
- Handler
- HandlerOpinion
- Auditer
- AuditOpinion
- Subscriber
- SubscriberOpinion
- SubscribeDate

### Archival Quality
- Archival Code
- Archive Date
- Archival Quality Desc
- QualityEvaluator

These are Metadata for Archival Security, Protection and Quality
Archival metadata design

Other events that metadata should record in database

- **Collect**
  - Transport the data archives from work team to archives room

- **Distribute**
  - Distribute certain data archives from archives room to engineers or department, who will not give back the data archives. Special user.

- **Circulate**
  - Serve the common user who can borrow and use

We extended DC standard
Case system----GeoAsset

Geological data management system
Case system----GeoAsset

Geological data management system

Retrieve result
TOPIC --- Standard & metadata structure

- Metadata design & structure
- International standard used
- System & technologies used
- Data flow & access
- Challenges to national database management
- Future plans to improve database management
International standard used

- Dublin Core Metadata: expanded
- ISO/19115 Metadata: GIS applied
- POSC Meta model: reference
TOPIC --- Standard & metadata structure

- Metadata design & structure
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## System & technologies used

<table>
<thead>
<tr>
<th>Operation System</th>
<th>Database system &amp; GIS system</th>
<th>Software develop tool</th>
<th>Desktop tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unix</td>
<td>Oracle</td>
<td>Microsoft VS.NET</td>
<td>Microsoft Office</td>
</tr>
<tr>
<td>Linux</td>
<td>SqlServer</td>
<td>Java</td>
<td></td>
</tr>
<tr>
<td>AIX</td>
<td>ArcInfo</td>
<td>Delphi</td>
<td></td>
</tr>
<tr>
<td>Windows 2003 server</td>
<td>MapInfo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windows XP</td>
<td>Access</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Etc.</td>
<td>Visual Foxpro</td>
<td></td>
</tr>
</tbody>
</table>
**TOPIC --- Standard & metadata structure**

- Metadata design & structure
- International standard used
- System & technologies used
- **Data flow & access**
- Challenges to national database management
- Future plans to improve database management
(1) There are more than 140 data management departments in SINOPEC. All the data management departments form a huge network.

(2) Data management departments have to collect papers, pictures, the wellbores, tapes and so on in time everyday. And range them clearly and logically. Engineers can use the data quickly.

(3) According to the regulation, some certain data must be transferred to Country data center.
Geological data management system-GeoAsset

This shows the data flow in oilfield. The Geological data manager collect the data from the work site, and organize them as archival file. Then the data can be shared in scope of oilfield. Users can browse the document, digital file, data table, or picture on intranet.
This shows the data flow in SINOPEC headquarter. The Geological data manager receive the data from oilfield, and reorganize them. Then the data can be shared in scope of whole SINOPEC. Users can browse the document, digital file, data table, or picture on intranet.
TOPIC --- Standard & metadata structure

- Metadata design & structure
- International standard used
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- Data flow & access
- Challenges to national database management
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Challenges to data management

(1) The situation of every branches in oilfield is quite different. The data standard varies too. It’s a huge project to unify the data standard and design a big new system as E&P data center.

(2) A large amount of data in every branches need a scientific and safe backup Strategy.

A well-designed E&P data center system will be the best solution for keeping the company’s asset.
TOPIC --- Standard & metadata structure

- Metadata design & structure
- International standard used
- System & technologies used
- Data flow & access
- Challenges to your national database management
- Future plans to improve database management
plan to improve database management

(1) The call of “six unified” to IT department in SINOPEC, is also apply to oil & gas data management project.

“unified layout
unified standard
unified design
unified investing
unified constructing
unified management”

(2) Based on the existed database, a unified data management platform should be designed to integrate the old E&P database and update the situation of data management, so as to enhance the Multi-Disciplinary Data Sharing.
Topics

- Background of Oil & Gas activity in China
- Standard & metadata structure
- Recommendations
Required capacities to be developed by the member countries

(1) The ability to understand the standard for CCOP
(2) A set of methodology about data management
(3) Specialists who can help other countries to construct database
(4) Have a case project for other countries to study

Recommendation about knowledge sharing in SINOPEC

We can choose a project to conduct experiments, to test the research result and show the practicality. After this, we can popularize to more area, or give some suggestions.
Recommendation about CCOP natural gas metadata design

1. Natural gas data should be in this table, metadata of E&P can work too.
2. Focus on that the E&P process of Natural Gas is special.
3. Static data and Dynamic data is also different.

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Content</th>
<th>Store Method</th>
<th>location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure data</td>
<td>data</td>
<td>database</td>
<td>Static/ Dynamic</td>
</tr>
<tr>
<td></td>
<td>metadata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonstructural data</td>
<td>Document, Picture, Bulk data, drill core</td>
<td>CD, tape, film, paper, tape, Digital file</td>
<td>shelf, ATM, shelf, Hard disk</td>
</tr>
<tr>
<td></td>
<td>data</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>metadata</td>
<td>table</td>
<td>Oracle</td>
</tr>
<tr>
<td>GIS data</td>
<td>Usually used</td>
<td>database</td>
<td>Oracle Spatial</td>
</tr>
<tr>
<td></td>
<td>data</td>
<td></td>
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<tr>
<td></td>
<td>metadata</td>
<td>database</td>
<td>Oracle</td>
</tr>
<tr>
<td></td>
<td>Unusually used</td>
<td>data</td>
<td>Digital file</td>
</tr>
<tr>
<td></td>
<td>metadata</td>
<td>database</td>
<td>Oracle</td>
</tr>
</tbody>
</table>
(1) Using "7W rule" to analyze the natural gas activity

we need to describe all the activities and attributes about natural gas.

who  when  where  which  why  how  what

If we answer this 7 questions, we can know how the natural gas data is created, on what condition, and what the result should be.

<table>
<thead>
<tr>
<th>Activity name</th>
<th>who</th>
<th>when</th>
<th>Where</th>
<th>Which</th>
<th>why</th>
<th>what</th>
<th>how</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of output composition</td>
<td>Technician</td>
<td>2009-3-21</td>
<td>Laboratory</td>
<td>Gas field</td>
<td>Give timely measurement to decrease the output decline</td>
<td>Keep on knowing the composition of output</td>
<td>According to the changes of output</td>
</tr>
<tr>
<td>Activity describe</td>
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</tr>
</tbody>
</table>

According to the changes of output, Analysis the natural decline of the certain gas field, Keep on knowing the composition of output, Give timely measurement to decrease the output decline.
(2) Using metadata to describe activity data set

Same to the concept of GIS data set, activity creates data sets of natural gas. May be the natural gas metadata diagram should be extended as follow:

Compare to the metadata of GIS, The natural gas metadata will be very different. May be the Gas composition, the condition of process, the rules of operation will impact to the data result.
1) There will be
- Drilling dataset
- Analysis of Gas composition dataset
- Production dataset
- Gas well static dataset
- Gas well dynamic dataset
- Well logging dataset

2) Metadata should record:
- Conditions of activity
- Parameters of process
- Formula of sum total
- Rules of data integration
- Relations between dynamic and static data
  Etc.
Thanks!