Geoscience Databases

The 800 pound gorilla in the room of the modern digital world

How did we get where we are?

What are some of the issues in existing data ?

- Obviously bad data (e.g. typos)
- Subtle and more pernicious

Why has it been so difficult to wield potential power of these databases given the advances of modern technical applications?

Technical approach being presented has proven to work (or at least provide a good start) in addressing this problem*

Does not require new people, more IT people; just some training and organizational commitment

My perspective from a 30 year career in the Petroleum industry

Database issues in ArcGIS – Geoscience specific

My experience as a geoscientist with ArcGIS and databases

- My job was to teach spatial analysis and map based play assessment
- The reality of the job: resolving data issues / creating data sets from graphics and digitized hand drawn illustrations.

Data issue remains one of the big stumbling blocks to ArcGIS usage in geoscience

Perhaps you have heard these comments from a geologist:

- I have found flaws in this database
- I cannot use it with confidence
- I'm starting over from scratch

Reality is:
World is mature with respect to exploration (lots of data out there)
Applications are very capable and not limited in scope or scale

Why are there so many persistent issues with data quality and data conditioning

Description of Data Problem

Technical Issues: Data Complexity

Geoscience data has (at least) 5 degrees of freedom

- X Y (spatial coordinates)
- Z (value – e.g. depth of formation)
- Geologic time
- Changing geologic classification schemes (an evolving scientific discipline)

  Data sets that are captured reflect the concepts and time schemas that were in place the data was captured

  - Litho-stratigraphy
  - Stratigraphic "type sections" or locales
  - Biostratigraphy data
  - Palynology data
  - Chrono-stratigraphy from different schema around the world
  - Radiometric Dates – (needs reverse translation)

Note:
This discussion is about the consistency of the data such that it can be analyzed as it currently exists.
Interpreted tops, unconformity surfaces, etc. still are the primary venue of a geoscientist and a separate discussion

Confounding Issues

(if you don't know where you are going… all roads lead you there.)

Organizational Issues

Data issues are poorly appreciated at an executive level

Industry has already poured lots of money into the problem

Data problems are often viewed as principally an IT issue, not requiring a cross disciplinary solution

End users (geoscientists) often create their own local data (nut piles) and become married to their own databases and database structures

Sloppy usage by geoscientists and mixing of chrono-stratigraphic and lithologic terms (ongoing issue)

We have met the enemy and he is us !

Why the obsession with geologic time ?

- Provides fundamental structure to understand sedimentary stacking patterns and groupings of sediment packages
- Geologic plays and play elements are organized by temporal stratigraphy
- Historic calibration of field sizes are organized by age classification
- These issues apply for both conventional and unconventional exploration

Bottom line

Lack of attention to how data gets classified has profound influence on what constitutes hydrocarbon potential or lack thereof and (by extension) exploration strategy

Desired State of Databases

(easy to describe…. challenging to do)

Uniform and consistent time – stratigraphic formats for all the data
Interpretation consistent with that common temporal framework

How do we get there from here?

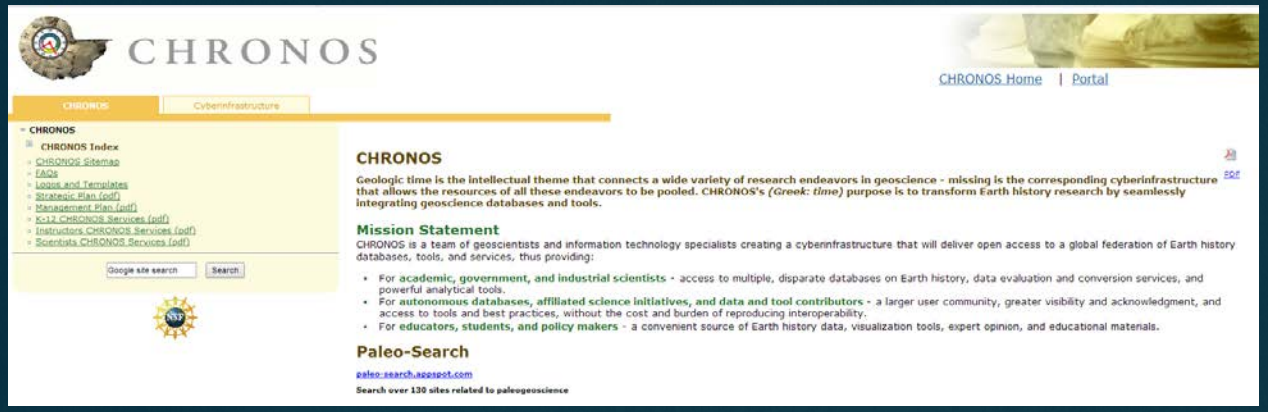
First step is to get the existing databases into a consistent modern time framework

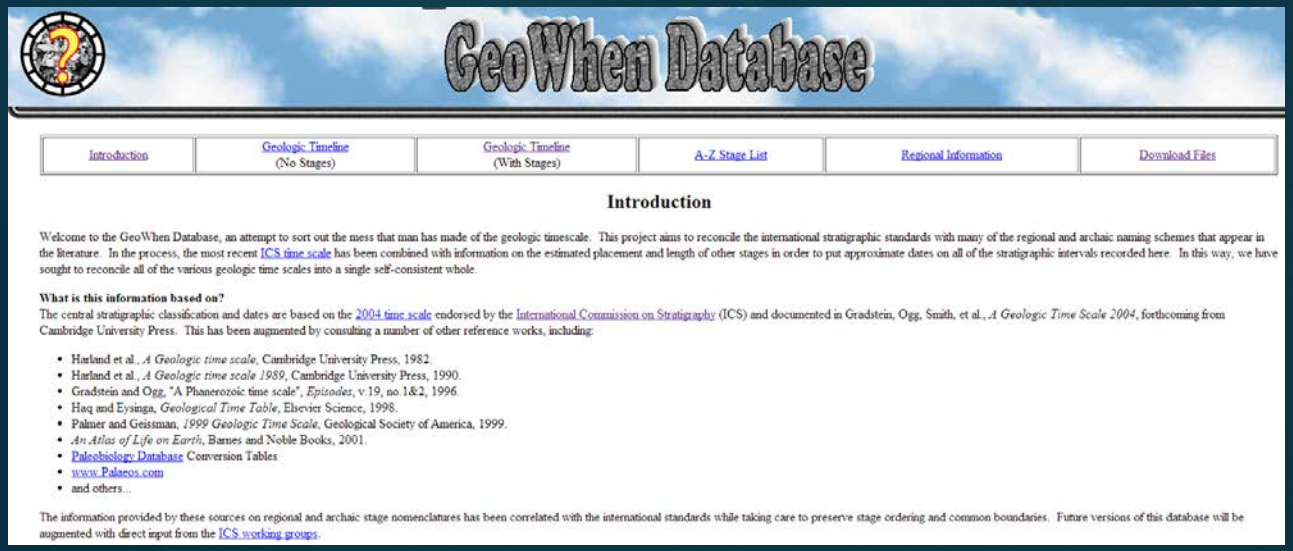
- What does a typical “before” data set look like
- How do you deal with databases that have inconsistent attribution
- How can you systematically and thoroughly reclassify your data into a consist framework.

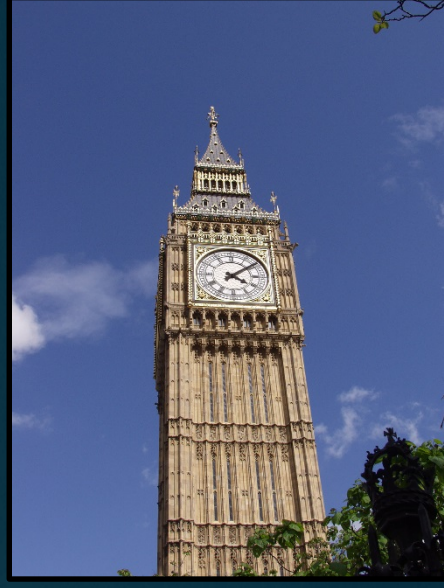
A Consistent Temporal Framework

Lots of “google help” out there albeit dated

Some useful reference to geologic age classifications







But……

This reference is the 2004 standard.

Standards are almost continually being modified

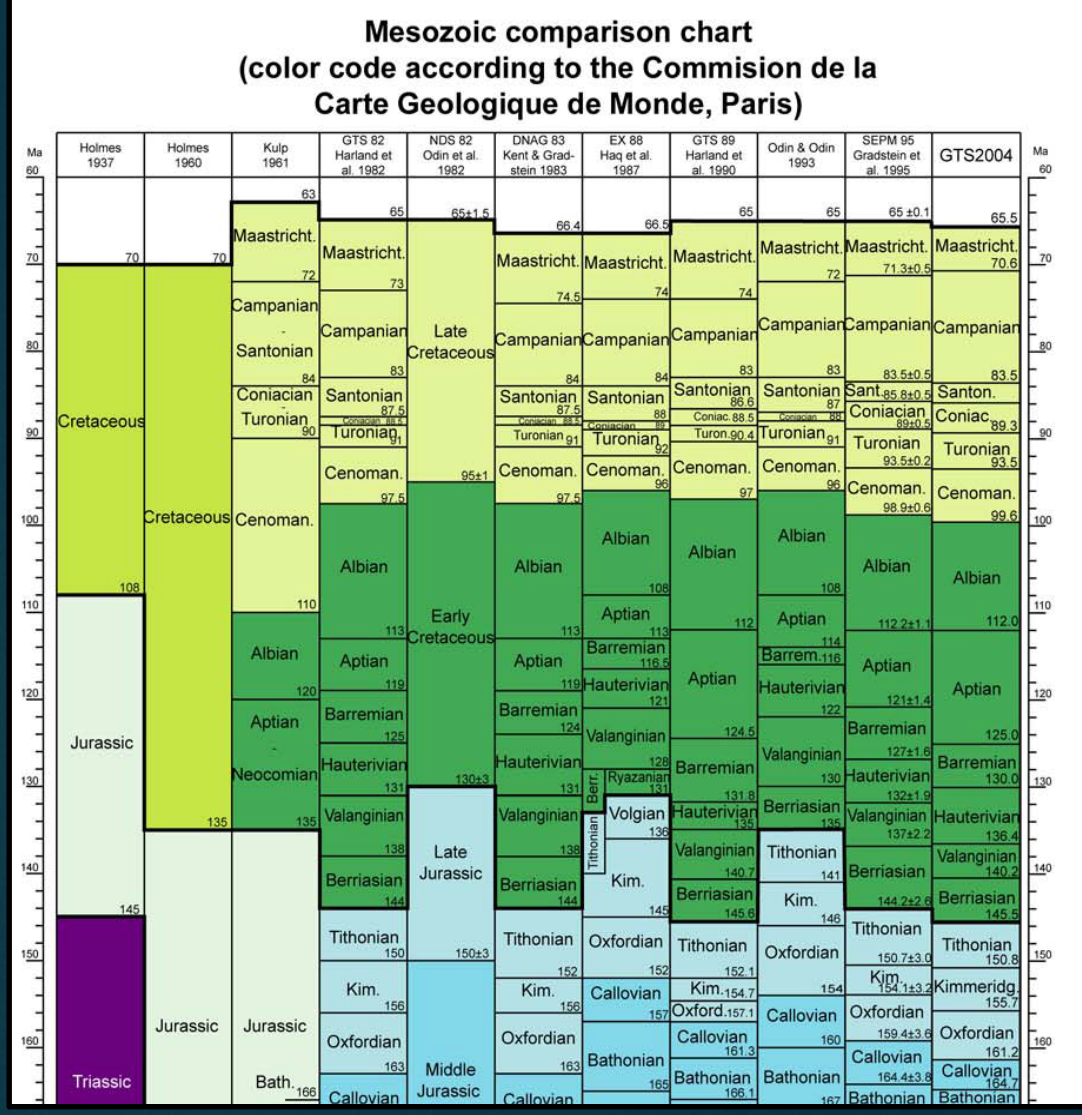
Geologic Ages are a Moving Target

Geologic Stage to MYBP age refinement (1937 – 2004)

Databases frequently lock in the age schemas at the time when they were captured.

In many cases other classifications are also included:

- Litho-stratigraphy
- Type sections or locales
- Local formation names
- Ages having no formal definition (e.g. Middle Cretaceous or Middle Oligocene)



Geologic Time changes through time

International Commission on Stratigraphy

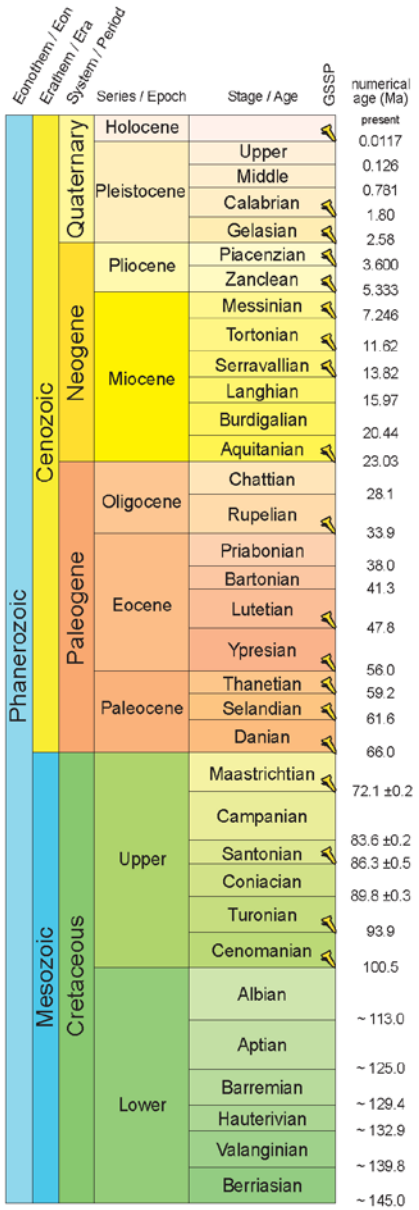
INTERNATIONAL CHRONOSTRATIGRAPHIC CHART

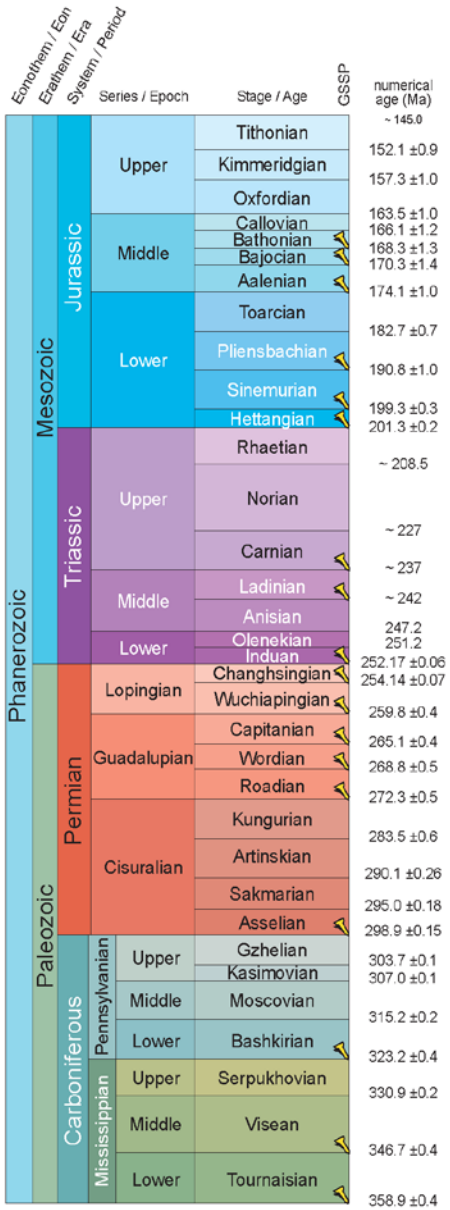
IUGS

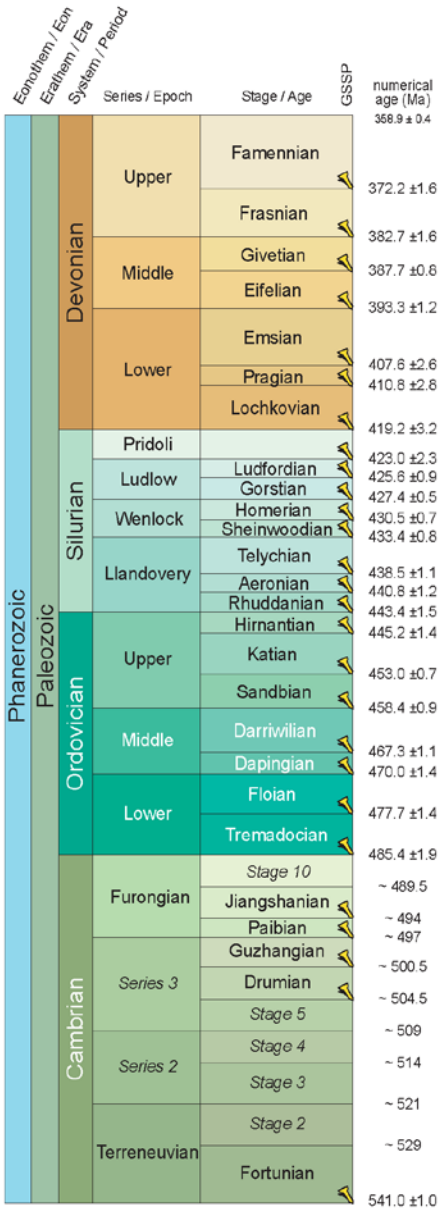
www.stratigraphy.org

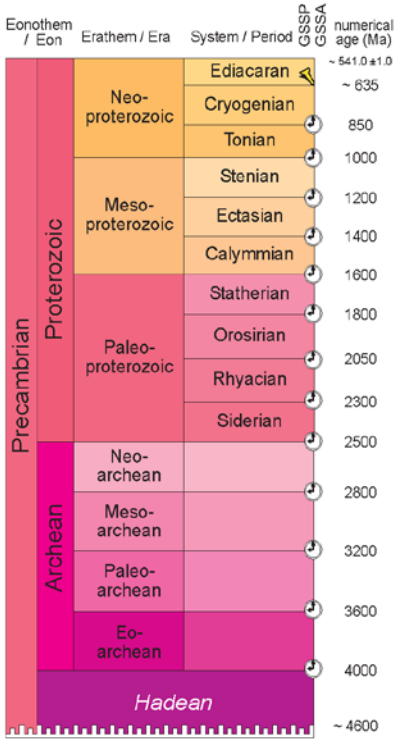
International Commission on Stratigraphy

v 2014/02









Units of all ranks are in the process of being defined by Global Boundary Stratotype Section and Points (GSSP) for their lower boundaries, including those of the Archean and Proterozoic, long defined by Global Standard Stratigraphic Ages (GSSA). Charts and detailed information on ratified GSSPs are available at the website http://www.stratigraphy.org. The URL to this chart is found below.

Numerical ages are subject to revision and do not define units in the Phanerozoic and the Ediacaran; only GSSPs do. For boundaries in the Phanerozoic without ratified GSSPs or without constrained numerical ages, an approximate numerical age (~) is provided.

Numerical ages for all systems except Lower Pleistocene, Permian, Triassic, Cretaceous and Precambrian are taken from 'A Geologic Time Scale 2012' by Gradstein et al. (2012); those for the Lower Pleistocene, Permian, Triassic and Cretaceous were provided by the relevant ICS subcommissions.

Coloring follows the Commission for the Geological Map of the World (http://www.ccgm.org)

To cite: Cohen, K.M., Finney, S.C., Gibbard, P.L. & Fan, J.-X. (2013; updated) The ICS International Chronostratigraphic Chart. Episodes 36: 199-204.

URL: http://www.stratigraphy.org/ICSchart/ChronostratChart2014-02.pdf

Translation Table of International Standard Geologic Ages

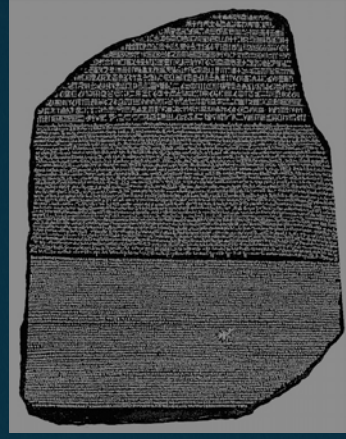


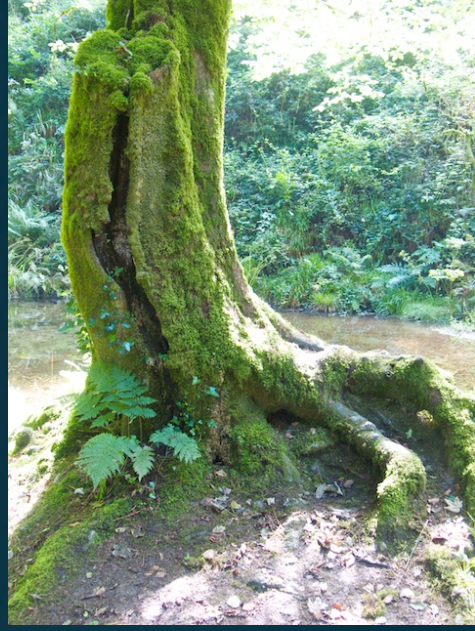
Table shown below is based on GTS 2014 Classification Scheme

Coarser time intervals provided for flexibility

Can be joined to your data (once conditioned) to standardize it to the International Commission on Stratigraphy GTS2014*

Period	Epoch	Stage	Young_Age_MYBP	Early_Age_MYBP	Interval_length_MY
Neogene	Miocene	Aquitanian	20.43	23.03	2.6
Paleogene	Oligocene	Chattian	23.03	28.4	5.37
Paleogene	Oligocene	Rupelian	28.4	33.9	5.5
Paleogene	Eocene	Priabonian	33.9	37.2	3.3
Paleogene	Eocene	Bartonian	37.2	40.4	3.2
Paleogene	Eocene	Lutetian	40.4	48.6	8.2
Paleogene	Eocene	Ypressian	48.6	55.8	7.2
Paleogene	Paleocene	Thanetian	55.8	58.7	2.9
Paleogene	Paleocene	Selandian	58.7	61.7	3
Paleogene	Paleocene	Danian	61.7	65.5	3.8
Cretaceous	Late Cretaceous	Maastrichtian	65.5	70.6	5.1
Cretaceous	Late Cretaceous	Campanian	70.6	83.5	12.9
Cretaceous	Late Cretaceous	Santonian	83.5	85.8	2.3
Cretaceous	Late Cretaceous	Coniacian	85.8	89.3	3.5
Cretaceous	Late Cretaceous	Turonian	89.3	93.5	4.2
Cretaceous	Late Cretaceous	Cenomanian	93.5	99.6	6.1
Cretaceous	Early Cretaceous	Albian	99.6	112	12.4
Cretaceous	Early Cretaceous	Aptian	112	125	13
Cretaceous	Early Cretaceous	Barremian	125	130	5
Cretaceous	Early Cretaceous	Hauterivian	130	136.4	6.4
Cretaceous	Early Cretaceous	Valanginian	136.4	140.2	3.8
Cretaceous	Early Cretaceous	Berriasian	140.2	145.5	5.3

GTS2014 Stage Table – ArcGIS format

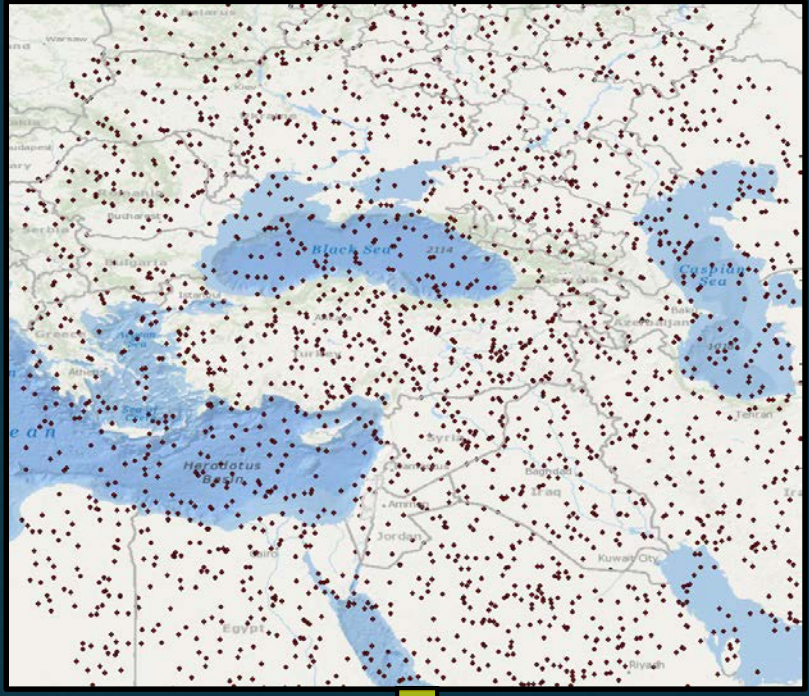


How do we get these databases under control and deal with all the legacy data chaos?

Extract a unique age list from your Data

Process your data (Origin Data) using the frequency tool to produce a unique list of age names in a results table more commonly called a Frequency Table

Build this using the highest resolution age intervals that are in the data table



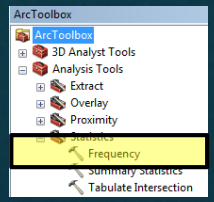
Table

Geochem_demo_data

OBJECTID *	Location_ID	Geologic Age	Latitude	Longitude	TOC_Measured	HI_measured	Ro_Measured
10	LocationID_10	Norian	20.295145	27.276593	1.347696	41	1.262788
11	LocationID_11	Norian	23.299313	26.395017	10.027879	559	1.234983
12	LocationID_12	Rupelian	50.32628	55.087726	10.438838	387	1.238575
13	LocationID_13	Valaginian	23.297206	39.966545	10.945003	176	1.270103
14	LocationID_14	Cenomanian	28.431503	49.29079	2.754814	123	1.437452
15	LocationID_15	Burdigalian	24.739605	40.117508	3.386568	467	1.782861
16	LocationID_16	Bosier	50.23318	29.011668	6.672347	46	1.291686
17	LocationID_17	Bashkirian	48.36773	46.351815	9.891457	137	1.417735
18	LocationID_18	Messenian	41.852891	34.470115	2.753026	565	1.388446
19	LocationID_19	Hith Formation	33.515466	40.700087	10.373399	610	1.727712
20	LocationID_20	Tyumen Form	21.066271	21.056653	10.870801	421	1.257543
21	LocationID_21	Albian	53.070779	52.188359	2.164154	118	1.789436
22	LocationID_22	Tremadocian	41.80287	43.817965	6.411282	575	1.565293
23	LocationID_23	Beriasian	26.035813	38.298392	3.131873	164	1.469016
24	LocationID_24	Smack'ovr	38.447957	40.153793	1.506401	334	1.205389
25	LocationID_25	Serravalian	53.171418	54.524057	7.253647	24	1.211858
26	LocationID_26	Albian	28.618854	33.430442	1.122948	160	1.23926
27	LocationID_27	Artinskian	25.507647	28.730853	7.434379	46	1.200146
28	LocationID_28	Eagle Ford Shale	37.814353	51.116081	3.721663	160	1.505544
29	LocationID_29	Oxfordian	27.922867	52.840423	8.894972	613	1.467583
30	LocationID_30	Fammenian	54.921514	20.517828	5.68747	389	1.20989
31	LocationID_31	Bajocian	41.685178	39.191844	10.211374	190	1.531269
32	LocationID_32	Bossier	22.8562	44.375483	6.662113	178	1.228565
33	LocationID_33	Tremadolcian	22.251102	50.108333	9.982699	268	1.317814
34	LocationID_34	Smackover	33.134654	43.555874	5.717075	469	1.455667

1 (0 out of 10000 Selected)

Origin Data



unique_name_list

OBJECTID *	DatabaseName *	Count_DatabaseName
68	Ypresian	132
65	Visean	143
63	Valaginian	137
60	Tremadocian	145
61	Tremadolcian	126
59	Tournaisian	131
58	Toarcian	141
9	Bazhenov Fm.	120
10	Bazhenov Formation	120
13	Bosier	141
14	Bossier	168
32	Hith Formation	145
46	Portlandian	113
57	Tithonian	137
66	Volgian	141
56	Thanetian	141
23	Cib Op	114
49	Serravalian	134
48	Sakmanian	122
47	Rupelian	128
31	Hantkenina alabamensis	131
21	Chartmouthian	134
45	Pliensbachian	119
44	Oxfordian	242
41	Middle Oligocene	130

0 (0 out of 68 Selected)

Frequency Table

Examples of issues in Database Tables

Multiple spellings / Litho-stratigraphy

Litho-stratigraphy

Older or alternate age classification

64	Smack'ovr
40	Smack. Form.
48	Smackover
41	Smackovr Fm.
75	Tannezuft Fm.
19	Tartarian

Inconsistent spelling / multiple entries for same interval

3	Maastrichtian
56	Messenian
2	Messinian

Litho-stratigraphy / type section

Biostratigraphy

Litho-stratigraphy

37	Cenomanian
18	Chartmouthian
65	Chattian
22	Cib Op
46	Coniacian
13	Danian
62	Domanic Formation
57	Eagle Ford Shale

Litho-stratigraphy

Inconsistent spelling / multiple entries for same interval

Multiple spellings / Litho-stratigraphy

Inconsistent spelling / multiple entries for same interval

Trailing space

61	Bazhenov Formation
28	Beriasian
26	Berriasian
50	Bosier
49	Bossier
53	Burd.
54	Burdigalian
6	Callovian
30	Callovian

Add a column in your Frequency Table to contain correct ages that are standardized: The resultant table is called a Translation Table

Note:
This remapping step is the most important step to get right and will require geoscience experience

DatabaseName *	Count_DatabaseName
Ypresian	13
Visean	14
Valaginian	13
Tremadocian	14
Tremadolcian	12
Tournaisian	13
Toarcian	14
Bazhenov Fm.	12
Bazhenov Formation	12
Bosier	14
Bossier	16
Hith Formation	14
Portlandian	11
Tithonian	13
Volgian	14
Thanetian	14
Cib Op	11
Serravalian	13
Sakmanian	12
Rupelian	12
Hantkenina alabamensis	13
Chartmouthian	13
Pliensbachian	11
Oxfordian	24
Middle Oligocene	13
Norian	25
Moscovian	14
Tyumen Form	14
Messenian	13
Messinian	14
Maastrichtian	13
Ludlovian	14
Vasyugan Form.	14
Domanic Formation	13
Kimmeridgian	12
Smack'ovr	13
Smack. Form.	12

Add a column in your Origin Table to receive the remapped attributes

Location_ID	Latitude	Longitude	TOC_Measured	HI_measured	Ro_Measured	Shape *	DatabaseName	Corrected_stage_name
LocationID_22	41.80287	43.817965	6.411282	575	1.565293	Point	Tremadocian	<Null>
LocationID_23	26.035813	38.298392	3.131873	164	1.469016	Point	Beriasian	<Null>
LocationID_24	38.447957	40.153793	1.506401	334	1.205389	Point	Smack'ovr	<Null>
LocationID_25	53.171418	54.524057	7.253647	24	1.211858	Point	Serravalian	<Null>
LocationID_26	28.618854	33.430442	1.122948	160	1.23926	Point	Albian	<Null>
LocationID_27	25.507647	28.730853	7.434379	46	1.200146	Point	Artinskian	<Null>
LocationID_28	37.814353	51.116081	3.721663	160	1.505544	Point	Eagle Ford Shale	<Null>
LocationID_29	27.922867	52.840423	8.894972	613	1.467583	Point	Oxfordian	<Null>
LocationID_30	54.921514	20.517828	5.68747	389	1.20989	Point	Fammenian	<Null>
LocationID_31	41.685178	39.191844	10.211374	190	1.531269	Point	Bajocian	<Null>
LocationID_32	22.8562	44.375483	6.662113	178	1.228565	Point	Bossier	<Null>
LocationID_33	22.251102	50.108333	9.982699	268	1.317814	Point	Tremadolcian	<Null>
LocationID_34	33.134654	43.555874	5.717075	469	1.455667	Point	Smackover	<Null>
LocationID_35	23.095325	29.141248	5.723492	280	1.423933	Point	Campanian	<Null>
LocationID_36	35.551456	21.296946	7.890811	167	1.246755	Point	Middle Cretaceous	<Null>
LocationID_37	27.579685	42.429348	3.771189	300	1.245498	Point	Coniacian	<Null>
LocationID_38	51.628658	54.097469	6.957211	158	1.723833	Point	Oxfordian	<Null>
LocationID_39	39.781353	44.792302	10.5578	525	1.869921	Point	Albian	<Null>
LocationID_40	46.765274	38.58346	1.845597	535	1.258939	Point	Bosier	<Null>
LocationID_41	34.327724	38.424833	1.476917	618	1.222225	Point	Hantkenina alabamensis	<Null>
LocationID_42	26.109318	42.975859	1.533098	189	1.570858	Point	Smackovr Fm.	<Null>
LocationID_43	33.013467	30.400282	4.6009	213	1.364368	Point	Albian	<Null>
LocationID_44	48.279175	34.521081	6.364733	160	1.577698	Point	Callovian	<Null>
LocationID_45	34.897333	49.933678	6.258836	506	1.47717	Point	Smack'ovr	<Null>
LocationID_46	51.570564	38.135931	7.822373	49	1.368444	Point	Aptian	<Null>

Join the Translation Table to the Origin Table

To make permanent export the feature data set with the join in place

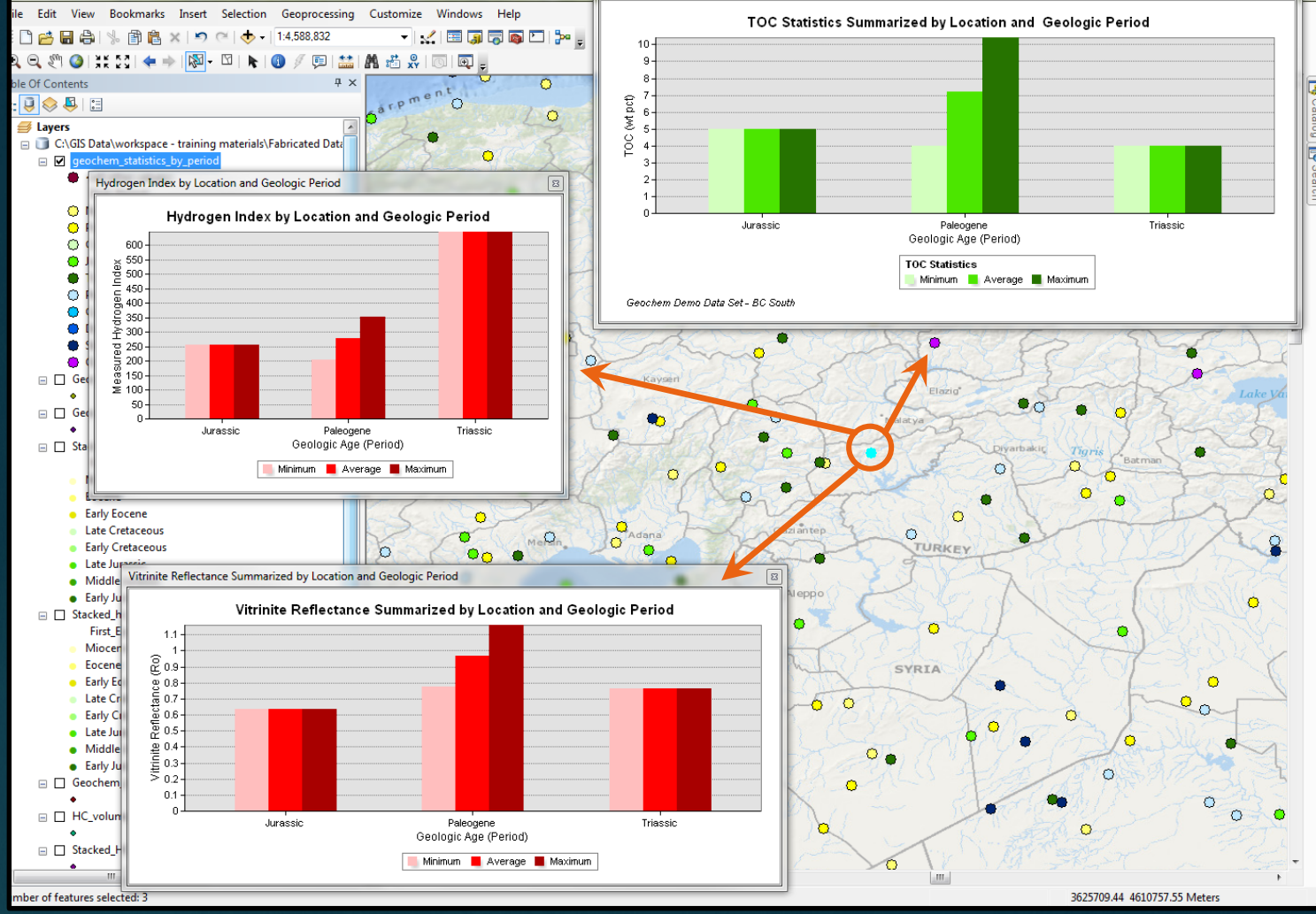
2_mod_BCS

User_defined	Period	Epoch	Stage *	Late_Age_MYBP	Early_Age_MYBP	time_interval_MY
Undefined	Paleogene	Paleocene	Danian	61.6	66	4.4
Paleocene (undifferentiated)	Paleogene	Paleocene (undifferentiated)	Paleocene (undifferentiated)	56	66	10
Paleogene (undifferentiated)	Paleogene	Paleogene (undifferentiated)	Paleogene (undifferentiated)	33.9	66	32.1
Senonian	Cretaceous	Late Cretaceous	Maastrichtian	66	72.1	6.1
Senonian	Cretaceous	Late Cretaceous	Campanian	72.1	83.6	11.5
Senonian	Cretaceous	Late Cretaceous	Santonian	83.6	86.3	2.7
Senonian	Cretaceous	Late Cretaceous	Coniacian	86.3	89.8	3.5
Gallic	Cretaceous	Late Cretaceous	Turonian	89.8	93.9	4.1
Gallic	Cretaceous	Late Cretaceous	Cenomanian	93.9	100.5	6.6
Late Cretaceous (undifferentiated)	Cretaceous	Late Cretaceous (undifferentiated)	Late Cretaceous (undifferentiated)	66	100.5	34.5
Neocomian	Cretaceous	Early Cretaceous	Albian	100.5	113	12.5
Neocomian	Cretaceous	Early Cretaceous	Aptian	113	125	12
Neocomian	Cretaceous	Early Cretaceous	Barremian	125	129.4	4.4
Neocomian	Cretaceous	Early Cretaceous	Hauterivian	129.4	132.9	3.5
Neocomian	Cretaceous	Early Cretaceous	Valanginian	132.9	139.8	6.9
Neocomian	Cretaceous	Early Cretaceous	Berriasian	139.8	145	5.2
Early Cretaceous (undifferentiated)	Cretaceous	Early Cretaceous (undifferentiated)	Early Cretaceous (undifferentiated)	100.5	145	44.5
Cretaceous (undifferentiated)	Cretaceous	Cretaceous (undifferentiated)	Cretaceous (undifferentiated)	66	145	79
Malm	Jurassic	Late Jurassic	Tithonian	145	152.1	7.1
Malm	Jurassic	Late Jurassic	Kimmeridgian	152.1	157.3	5.2
Malm	Jurassic	Late Jurassic	Oxfordian	157.3	163.5	6.2
Malm	Jurassic	Late Jurassic (undifferentiated)	Late Jurassic (undifferentiated)	145	163.5	18.5
Dogger	Jurassic	Middle Jurassic	Callovian	163.5	166.1	2.6
Dogger	Jurassic	Middle Jurassic	Bathonian	166.1	168.3	2.2
Dogger	Jurassic	Middle Jurassic	Bajocian	168.3	170.3	2

1 (0 out of 160 Selected)

TOC_Measured	HI_measured	Ro_Measured	Shape *	DatabaseName	Corrected_stage_name	User_defined	Period	Epoch	Stage	Late_Age_MYBP	Early_Age_MYBP	time_interval_MY
9.783173	445	1.402589	Point	Tartarian	Capitanian	ndefined	Permian	Late Permian	Capitanian	259.8	265.1	5.3
4	141	0.676984	Point	Toarcian	Toarcian	ias	Jurassic	Early Jurassic	Toarcian	174.1	182.7	8.6
3	434	0.756623	Point	Famennian	Famennian	ndefined	Devonian	Late Devonian	Famennian	358.9	372.2	13.3
10	150	0.813409	Point	Portlandian	Tithonian	lalm	Jurassic	Late Jurassic	Tithonian	145	152.1	7.1
1.347696	41	1.262788	Point	Norian	Norian	ndefined	Triassic	Late Triassic	Norian	208.5	227	18.5
2	278	0.739639	Point	Ludlovian	Ludfordian	iddle Silurian	Silurian	Ludlovian	Ludfordian	423	425.6	2.6
2	290	0.590705	Point	Ypresian	Ypressian	ndefined	Paleogene	Eocene	Ypressian	47.8	56	8.2
9	467	1.454445	Point	Bashkirian	Bashkirian	ennsylvanian	Carboniferous	Late Carboniferous	Bashkirian	315.2	323.2	8
7.041239	369	1.771298	Point	Callovian	Callovian	ogger	Jurassic	Middle Jurassic	Callovian	163.5	166.1	2.6
5	588	0.707224	Point	Bosier	Tithonian	lalm	Jurassic	Late Jurassic	Tithonian	145	152.1	7.1
1	46	1.118469	Point	Bossier	Tithonian	lalm	Jurassic	Late Jurassic	Tithonian	145	152.1	7.1
10	120	0.604591	Point	Messenian	Messinian	ndefined	Neogene	Miocene	Messinian	5.33	7.25	1.92
6.516369	54	1.513955	Point	Liassic	Early Jurassic (undifferentiated)	ias	Jurassic	Early Jurassic (undifferentiated)	Early Jurassic (undifferentiated)	174.1	201.3	27.2
9	546	0.599624	Point	Portlandian	Tithonian	lalm	Jurassic	Late Jurassic	Tithonian	145	152.1	7.1
9	548	0.6362	Point	Sakmanian	Sakmarian	ndefined	Permian	Early Permian	Sakmarian	290.1	295	4.9
10	528	0.871749	Point	Cenomanian	Cenomanian	allic	Cretaceous	Late Cretaceous	Cenomanian	93.9	100.5	6.6
10.881573	365	1.209556	Point	Bajocian	Bajocian	ogger	Jurassic	Middle Jurassic	Bajocian	168.3	170.3	2
9	636	0.817052	Point	Barremian	Barremian	eocomian	Cretaceous	Early Cretaceous	Barremian	125	129.4	4.4
3	260	0.801042	Point	Tartarian	Capitanian	ndefined	Permian	Late Permian	Capitanian	259.8	265.1	5.3
3	8	0.895455	Point	Frasnian	Frasnian	ndefined	Devonian	Late Devonian	Frasnian	372.2	382.7	10.5
8.419821	494	1.502628	Point	Cib Op	Serravallian	ndefined	Neogene	Miocene	Serravallian	11.62	13.82	2.2
6	44	0.853977	Point	Serravalian	Serravallian	ndefined	Neogene	Miocene	Serravallian	11.62	13.82	2.2
8	378	0.68175	Point	Valaginian	Valanginian	eocomian	Cretaceous	Early Cretaceous	Valanginian	132.9	139.8	6.9
7	17	0.605897	Point	Bashkirian	Bashkirian	ennsylvanian	Carboniferous	Late Carboniferous	Bashkirian	315.2	323.2	8
8.734437	113	1.949301	Point	Tremadolcian	Tremadocian	ndefined	Ordovician	Early Ordovician	Tremadocian	477.7	485.4	7.7
4	170	0.73635	Point	Sakmanian	Sakmarian	ndefined	Permian	Early Permian	Sakmarian	290.1	295	4.9
3	404	0.60127	Point	Frasnian	Frasnian	ndefined	Devonian	Late Devonian	Frasnian	372.2	382.7	10.5
9	400	1.180837	Point	Bosier	Tithonian	lalm	Jurassic	Late Jurassic	Tithonian	145	152.1	7.1
7.07997	632	1.573949	Point	Tithonian	Tithonian	lalm	Jurassic	Late Jurassic	Tithonian	145	152.1	7.1
2	398	0.650766	Point	Bazhenov Formation	Tithonian	lalm	Jurassic	Late Jurassic	Tithonian	145	152.1	7.1
4	171	0.754958	Point	Berriasian	Berriasian	eocomian	Cretaceous	Early Cretaceous	Berriasian	139.8	145	5.2
4	42	0.603352	Point	Tartarian	Capitanian	ndefined	Permian	Late Permian	Capitanian	259.8	265.1	5.3
5.807195	588	1.546675	Point	Frasnian	Frasnian	ndefined	Devonian	Late Devonian	Frasnian	372.2	382.7	10.5
3	503	0.658621	Point	Hantkenina alabamensis	Priabonian	ndefined	Paleogene	Eocene	Priabonian	33.9	38	4.1
7	143	1.039669	Point	Hantkenina alabamensis	Priabonian	ndefined	Paleogene	Eocene	Priabonian	33.9	38	4.1
9	285	0.890474	Point	Rupelian	Rupelian	ndefined	Paleogene	Oligocene	Rupelian	28.1	33.9	5.8

1 (0 out of 10000 Selected)



Interactive graphs based on statistics from reclassified age attributes

Age intervals summarized in:

- **Total Organic Carbon**
- **Hydrogen Index**
- **Vitrinite Reflectance**

Recommendations

- Use the frequency tool in ArcGIS to thoroughly look through your existing data
- Commit to a chronostratigrapic standard (and age resolution) everyone wants to work in and carefully reconcile your data to it
- Build and maintain the translation tables
  - For your local data
  - For vendor data
  - For the age model standard

Initial processing and standardization will take a little addition time but there are big benefits:

1. Future raw data sets will have a process in place to deal with them more efficiently
2. All your age specific analysis will become much less daunting to do:
   - Hydrocarbon discovered volumes by age
   - Geologic parameter by age
   - Play assessments
3. Data cleanup product is data that is vetted and able to be loaded into more formal databases (e.g. Oracle)

View from Tenerife (Canary Islands) Mt Teide at sunset

Resources

Current International Commission on Stratigraphy: Time Stratigraphic Chart

http://www.chronos.org

http://www.stratigraphy.org/upload/bak/geowhen/index.html

Current International Commission on Stratigraphy: Time Stratigraphic Chart

http://www.stratigraphy.org/ICSchart/ChronostratChart2014-02.pdf