Appalachian Storage Hub (ASH) Project

Team Meeting Minutes

April 11, 2017 – 10:00 – 11:30 am

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Present: John Bocan, John Saucer, Jessica Moore, Phil Dinterman, Mary Behling, Gary Daft, Mike Hohn, Doug Patchen, Kris Carter, Brian Dunst, Toni Markowski, Steve Shank, Katie Schmid, Robin Anthony, Kyle Metz, Mohammad Fakhari, Mike Angle, Michael Solis

1) Strategy Progress

Strategy 1 – Data Collection (Jessica, WVGES) – WVGES continues to collect data on the ftp site, and has recently shared several MRCSP query/shapefile datasets for ranking purposes. Jessica noted that WV will provide the additional shapefiles Kris requested for gas storage fields, the Clinton/Medina interval, Newburg interval, and an infrastructure map for the AOI, all of which will be needed for ranking purposes. Jessica asked that the project team make a concerted effort to upload any remaining data or pertinent resources to the project ftp by the end of this month, so that WV staff can review, code, and incorporate this information into the project website.

Strategy 2 – Stratigraphic Correlation of Key Units (Kyle, ODGS) – ODGS has finalized its stratigraphic correlation and cross section work, and Kyle will upload pdf versions of these files to the ftp today for final review and approval by the research team. He has prepared a total of nine cross sections, three for each 'chunk' of the subsurface (Cambrian-Ordovician, Silurian-Devonian, and Devonian-Mississippian), with one strike and two dip sections for each interval. Please review and comment immediately.

Strategy 3 – Mapping (Kyle, ODGS) – ODGS has finalized its mapping work, and Kyle will upload pdf versions of these files to the ftp today for final review and approval by the research team. He has prepared a total of 18 maps, including structure and isopach for each interval of interest. Please review and comment immediately.

Kyle will also prepare map packs and final shapefiles for reporting purposes and to place on the website, once the research team has approved the maps.

Strategy 4 – Studies of Reservoir Character (Kris, PAGS) – PAGS has begun its petrographic analysis of a short list of thin sections for reservoirs in the AOI (64 total), but since the semi-annual partners meeting, it was decided that this work will not take priority over other field-level data compilation, assessment, and ranking. That said, we do hope to use these analyses to augment field-level reservoir ranking work that we do in the coming months.

PAGS worked with Doug Patchen to draft ranking criteria that will help focus PA's intended field-level reservoir characterization assessments for the project, while at the same time give the research team a jump on Strategy 5. The ranking criteria will be applied to each of four geologic interval types: mined-rock cavern (i.e., Greenbrier Ls), salt cavern (i.e., Saline F4 salt), depleted gas reservoirs, and gas storage fields.

The research team discussed the Excel workbook contents, and the following suggestions were made: (1) add 'acreage' as a ranking criterion for the depleted gas reservoirs and storage fields, with reasonable high/low cutoffs that can be evaluated relative to cumulative production (already identified as a ranking criterion); (2) if a field has a very low porosity (i.e., <=1%), then it really should not be ranked at all, regardless of what other ranking criteria may be applied; and (3) for the instance of mined-rock or salt caverns, the nearest/overlying municipality could be used as the geographic footprint (i.e., in lieu of a field boundary). Kris will revise the ranking criteria Excel workbook to reflect these modifications.

Kris proposed that the ranking be performed in two steps – first, a gross ranking of certain parameters (i.e., those readily available using the MRCSP's regional oil and gas fields GIS dataset) to generate a short list of candidate fields/areas for each of the four interval types; and second, a more granular ranking of the short list of fields/areas that made the initial cut. PAGS will perform the gross ranking work, but for the second step of the vetting process, all states will be asked to help come up with data/informed input on things like trap integrity, cumulative production, potential effects of well penetration, etc. to prepare the final rankings.

Kris indicated that PAGS can use the query/shapefile datasets already prepared by WVGES to start ranking depleted Rose Run, Oriskany, Upper Devonian, and Keener-Berea gas reservoirs, but that additional query-shapefile datasets (see page 1) will ultimately be need for this work.

ODGS offered to look at the thickness and extent of its Salina F4 salt maps, relative to existing infrastructure in the region (e.g., old salt caverns) and population centers, as a way of assisting PAGS in its ranking of this interval – all the more reason that any final comments for these maps be provided to ODGS immediately (and be sure that ODGS has been provided locations with digital log curves but also tops data that may have been derived from raster logs or drillers logs for your respective state). Jessica has some report documents on WV's salt caverns and will forward to Kyle for his use.

WVGES is building on the Greenbrier Ls maps prepared by ODGS to get more detailed, log-based information for the WV panhandle/southwestern PA to look at how not just minimum depth (i.e., 1,800 ft) might limit available areas for mining, but also facies changes within this geologic interval.

Strategy 5 – Ranking Criteria (Kris, PAGS) – See above for detailed discussion. PAGS is shooting to have the first-pass, 'gross' ranking criteria applied to all depleted gas reservoirs by next Thursday, April 20. Hopefully, this will also include the Newburg Sandstone and Clinton/Medina intervals, provided WVGES can compile query/shapefile datasets for these in the next few days.

Strategy 6 – Recommendations (open)

Strategy 7 – Suggestions for Follow-Up Study (open)

Strategy 8 – Project Management/Tech Transfer (Patchen) – Third quarter reporting (February-April 2017) is due to Doug by May 10. Doug and Kris will compile the research team's input and prepare the final quarterly report so that it can be share with project partners on or about May 17.

Doug submitted a no-cost extension request to the Foundation to give us the formal approval for July 31, 2017 as the project end date (rather than May 31, 2017, which is indicated in our current contractual documents). He has not received approval for this yet, but expects to soon.

Doug indicated that he is planning for the final project team/partners meeting to coincide with the public workshop for this project, so we have only one event to plan. As stated above, we expect the official project end date to be July 31. Our final project report must be completed by this date, so Doug is asking for everyone's draft final report input by July 24. Once Doug and Kris finalize the content and format of the final report, and confirm that WVGES has all the data parts and pieces ready to go on the website, we will provide

these final deliverables to the project partners on July 31. Doug expects to hold the final meeting in the third week of August at a location in Southpointe, Canonsburg, PA.

Final invoices must be submitted by research team members no later than August 31, 2017, to close out this project.

2) Semi-Annual Meeting Post Mortem

Deconstructing input from partners and attendees – Doug summarized the comments received from partners and advisory board members, which generally fell into one of three categories: (a) they wanted us to be looking at reservoir scale (i.e., pool level) by now, and we must get to this level for the final reporting; (b) they want us to be looking at gas storage fields in additional to just 'depleted gas reservoirs'; and (c) Doug has been asked to plan/provide another workshop, where regulators and industry from Texas come to Pittsburgh to talk with our state regulators about how to permit/regulate ethane storage fields.

Getting well-specific data to WVGES for ftp site – As indicated above, Jessica asked for any remaining data to be offered the research team to be uploaded to the ftp site by the end of April.

Wrap up big-picture work – As indicated above, ODGS has substantively completed this work. Kris added that once we all agree these products are final, they can be included in the third quarterly report and will be ready to plug into July's final report as well.

Strategies of focus moving forward (see Doug's notes, below) – These comments were discussed by the group and have been incorporated into the notes on each strategy discussed above.

- Need to re-focus on field and formation/reservoir level
- Applies to correlation, mapping, reservoir characterization
- Suggest this approach
    - (1) Need best possible map on Greenbrier thickness & extent
        - (a) Interested in remnants with lateral seals?
        - (b) Below 1,800 ft
    - (2) Need most detailed map possible of the Salina F salt
        - (a) May require using other data as well as digitized GR/BD logs
    - (3) Maps of gas fields by individual pays, youngest to oldest
    - (4) Confine to depths below 2,000 ft
    - (5) Select key fields based on size, thickness, porosity & available volume
    - (6) Correlate logs within the fields
    - (7) Produce isopach & net sand maps (as a measure of heterogeneity)
    - (8) Focus reservoir characterization studies on these fields
    - (9) In addition to gas fields, map all gas storage fields
    - (10) Select key storage fields using same criteria
- Wrap up all big picture work on cross sections and maps
- Kris needs to be involved in key field selection and characterization
- In summary:
    - a) Four-fold approach: Greenbrier, gas fields, gas storage fields, Salina F Salt
    - b) Get everyone involved, divide the work accordingly

3) Next Steps

Action items – see yellow highlighted text in this document

Project milestones – May 10 for third quarter report input; July 24 for draft final report input; July 31 for final report; single workshop for partners and public in August 2017 at Southpointe, Canonsburg, PA

Project invoicing – Keep the invoices coming. Our cost match is almost fulfilled, but we have a way to go on the billable project items.

Next meeting date/time – Based on the research team's workload, we will forego next month's teleconference, unless something comes up.

4) Adjourned 11:10 am

Strategies/Activities	Start Date	End Date
Strategy 1: Data Collection		
• Identify and assemble well log and core data	Month 1	Month 2

• Identify previous studies of interest	Month 1	Month 2
• Create a project database (format, prototype)	Month 1	Month 2
Strategy 2: Stratigraphic correlation of key units		
• Develop cross sections of the Salina Formation	Month 3	Month 8
• Develop cross sections of the Greenbrier Formation	Month 3	Month 8
• Develop cross sections of the Keener to Berea Interval	Month 3	Month 8
• Develop cross sections of the Upper Devonian Sandstones	Month 3	Month 8
• Develop cross sections of the Oriskany Sandstone	Month 3	Month 8
• Develop cross sections of the Clinton-Medina through Tuscarora Interval	Month 3	Month 8
• Develop cross sections of the Rose Run and Upper Sandy Member of the Gatesburg Formation	Month 3	Month 8
Strategy 3: Map the thickness, extent, and structure of potential storage units in the study area		
• Map the Salina Formation	Month 5	Month 7
• Map the Greenbrier Limestone	Month 5	Month 7
• Map the Keener-Berea, Upper Devonian, Oriskany, Clinton-Medina, and Gatesburg Formations	Month 5	Month 7
Strategy 4: Conduct studies of reservoir character		
• Characterize potential storage intervals in the Salina Formation	Month 5	Month 8
• Characterize potential storage intervals in the Greenbrier Formation	Month 5	Month 8
• Characterize potential storage pools in gas-depleted sandstone reservoirs	Month 5	Month 8
Strategy 5: Develop ranking criteria for potential storage zones		
• Determine criteria and weighted priority of potential storage zones	Month 8	Month 9
Strategy 6: Recommendations		
• Rank all candidates within each category	Month 10	Month 11
• Rank the top candidates in each category	Month 10	Month 11
Strategy 7: Suggestions for engineering follow-up study		
• Make suggestions for additional field and lab studies	Month 10	Month 11
Strategy 8: Project management and technology transfer		
• Project management	Month 1	Month 12
• Final Report	Month 11	Month 12
• Technology transfer		Month 12+ ongoing