

Exercise objective:


To predict lithology logs using the “*Lithology classification tool*”, which is part of the machine learning plugin.

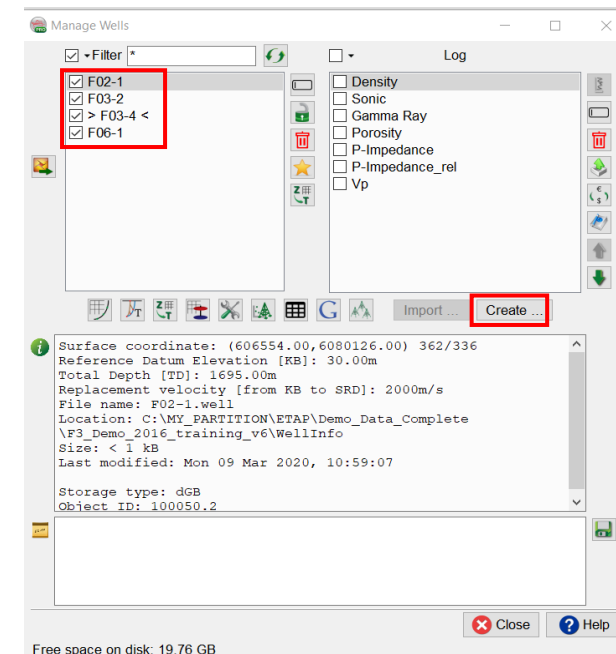
Well data Preparation

Well(s) need to be available in the survey. If not, **import** wells (track, logs, markers, optionally time-depth curve or checkshot).

Workflow:

For the purpose of this exercise, we will create a fake lithology log using Mathematics (as no lithology log exists in the survey)

1. **Open** the Well Manager .
2. **Select** All Wells in the “Well Manager”, and **Hit Create**.

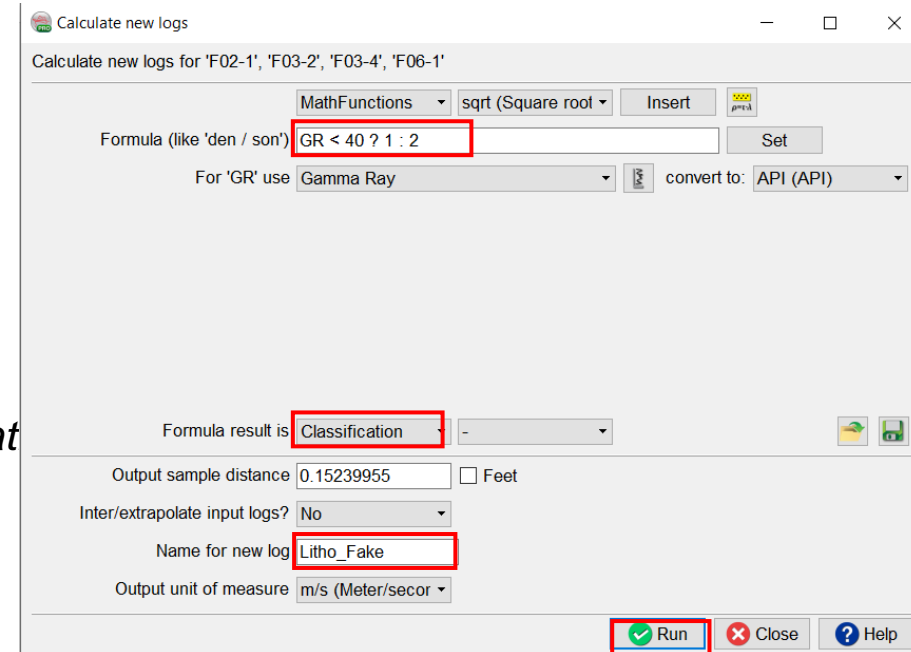


Workflow cont'd:

3. In the “Calculate a New Well Log” window, **Specify** the parameters as indicated below to create a fake litho-log:

- a. **Select**: MathFunctions.
- b. **Type** the Formula: $GR < 40 ? 1 : 2$
- c. **Hit** Set.
- d. **Select** Gamma Ray log.
- e. **Select** for the *Formula Results, Classification*
- f. **Type** Name for new log: Litho_Fake.
- g. **Select** Output Unit of Measures: None.


4. **Press** Run.

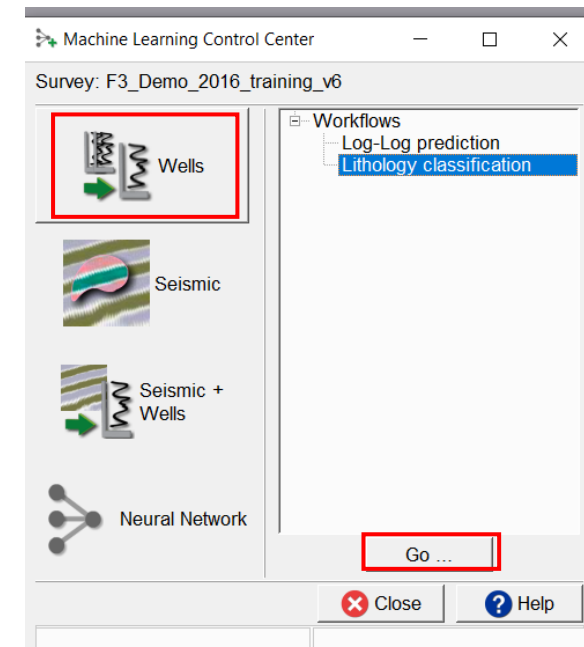


The screenshot shows the 'Calculate new logs' window. The title bar says 'Calculate new logs'. Below the title bar, it says 'Calculate new logs for 'F02-1', 'F03-2', 'F03-4', 'F06-1''. The window contains several fields and buttons:

- A dropdown menu for 'MathFunctions' is set to 'MathFunctions'.
- A dropdown menu for 'sqrt (Square root)' is set to 'sqrt (Square root)'.
- An 'Insert' button is next to the 'sqrt (Square root)' dropdown.
- A text input field for 'Formula (like 'den / son')' contains the formula 'GR < 40 ? 1 : 2', which is highlighted with a red box.
- A 'Set' button is next to the formula input field.
- A dropdown menu for 'For 'GR' use' is set to 'Gamma Ray'.
- A dropdown menu for 'convert to:' is set to 'API (API)'.
- A dropdown menu for 'Formula result is' is set to 'Classification', which is highlighted with a red box.
- An 'Output sample distance' input field contains the value '0.15239955'.
- An 'Inter/extrapolate input logs?' dropdown menu is set to 'No'.
- A 'Name for new log' input field contains the value 'Litho_Fake', which is highlighted with a red box.
- An 'Output unit of measure' dropdown menu is set to 'm/s (Meter/secor)'.
- A 'Run' button with a green checkmark icon is highlighted with a red box.
- A 'Close' button with a red X icon is next to the 'Run' button.
- A 'Help' button with a question mark icon is next to the 'Close' button.

Workflow cont'd:

5. **Open** the Machine Learning Control Center with the  icon.
6. **Click** on Wells.
7. **Select** *Lithology classification*.
8. **Hit** Go.



Workflow cont'd:

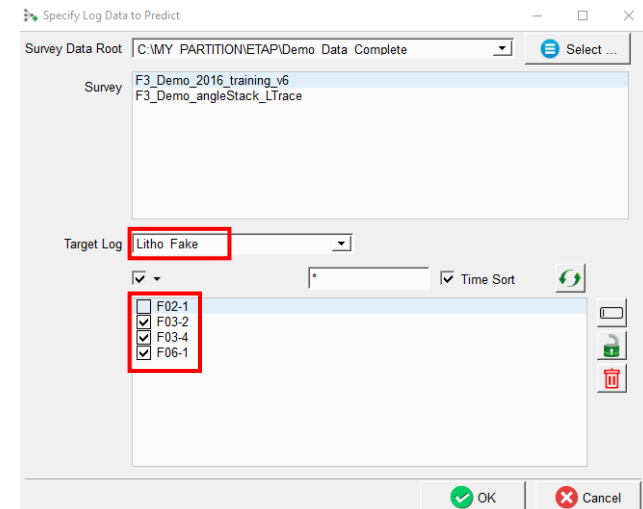
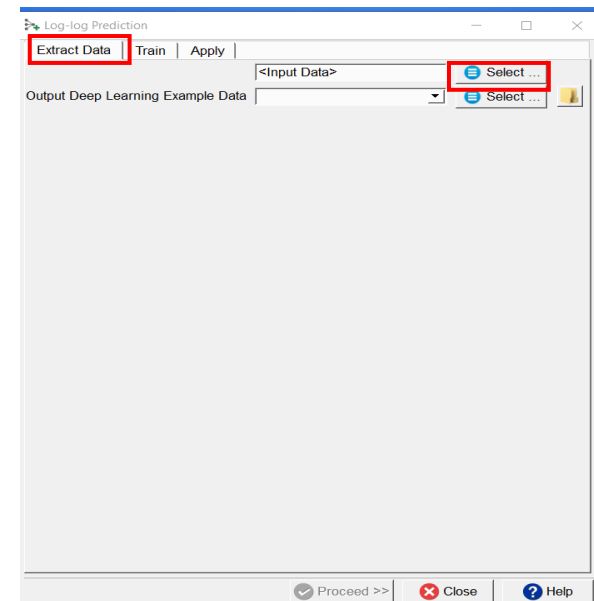
9. The Log-log prediction window pops up.

Select *Input Data*.

10. "Specify Log Data to predict" window pops up. **Select**:
Survey, Target Log, and Wells as indicated in the
window.


The well F02-1 is not selected, and will be used as a
blind well.

11. **Press** OK.

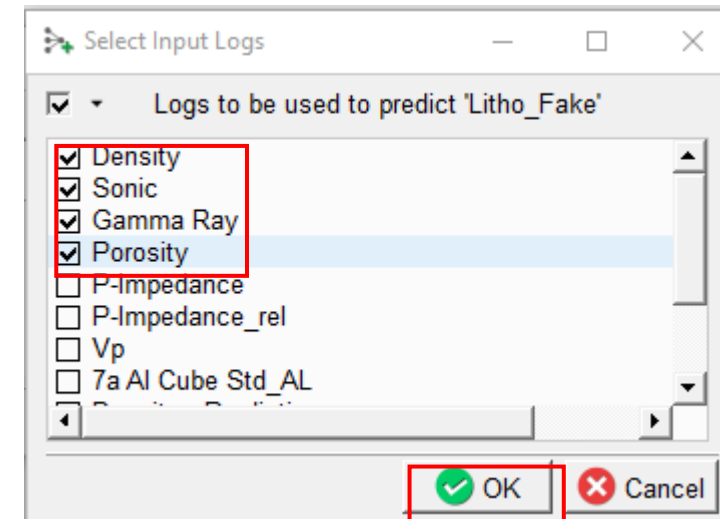
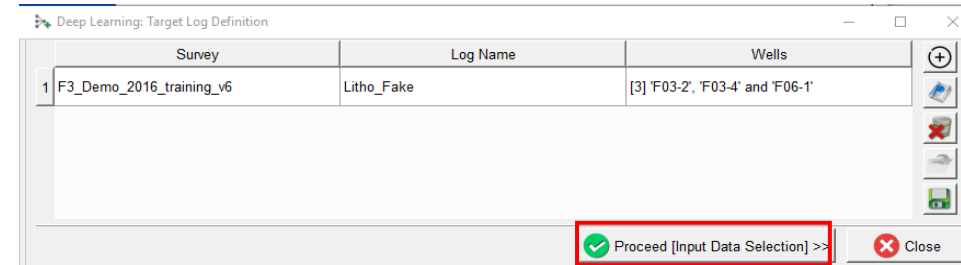


Workflow cont'd:

11. The “*Deep Learning: Target Log definition*” window pops up.

A new data selection from different survey definition can be added by clicking on  icon

12. **Press** Proceed [Input Data Selection].
13. In the “*Select Input Logs*” window, **Select** the Density, Sonic and Gamma Ray logs.
14. **Press** OK.



Workflow cont'd:

15. The “*Input Log Selection*” window pops up.

Input Logs can be modified here. Keep the default parameters as indicated in the window.

16. **Specify** a new name for the “*Output Deep Learning Example Data*” (e.g. *DL_Example_Data_Lithology_st10*).

17. **Press** Proceed.

	Survey	Input Log 1	Input Log 2	Input Log 3	Input Log 4
1	F3_Demo_2016_training_v6	Density	Sonic	Gamma Ray	Porosity

Stepout from center log sample: 10

Extract between: <Start of data> to <End of data>

Log sampling Z Step (m): 0.1524

Edge/Gap Policy: ☒ Exclude incomplete ☐ Add data

Output Deep Learning Example Data: DL_Example_Data_Litho_st10

Buttons: Proceed >>, Close, Apply

Workflow cont'd:

18. **Select** “New” at the Training Type checkbox.

19. The “*Train*” tab becomes active.

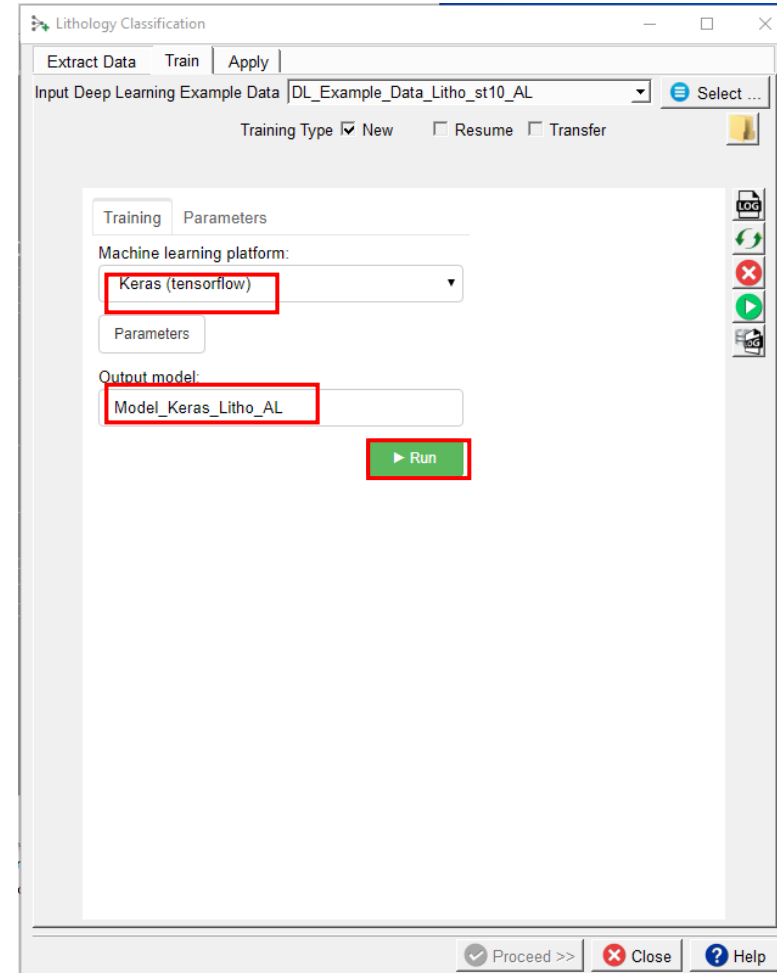
We train the extracted examples using the default learning algorithm (e.g. Keras (tensorflow)).

Different machine learning platforms and parameters can be tested.


20. **Keep** the defaults parameters.

Specify a new *Output model* name (e.g. Model_Keras_Litho_AL)

21. **Press** Run.

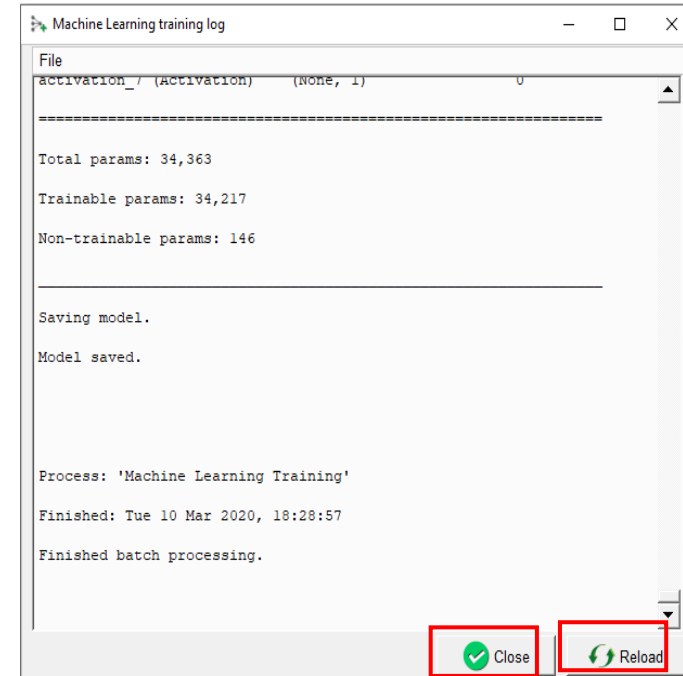


Workflow cont'd:

22. The Machine Learning training log file pops up. Otherwise **Click** on  icon.

23. **Press** Reload to refresh the window.

24. When the processing is done, **Close** the training log file.

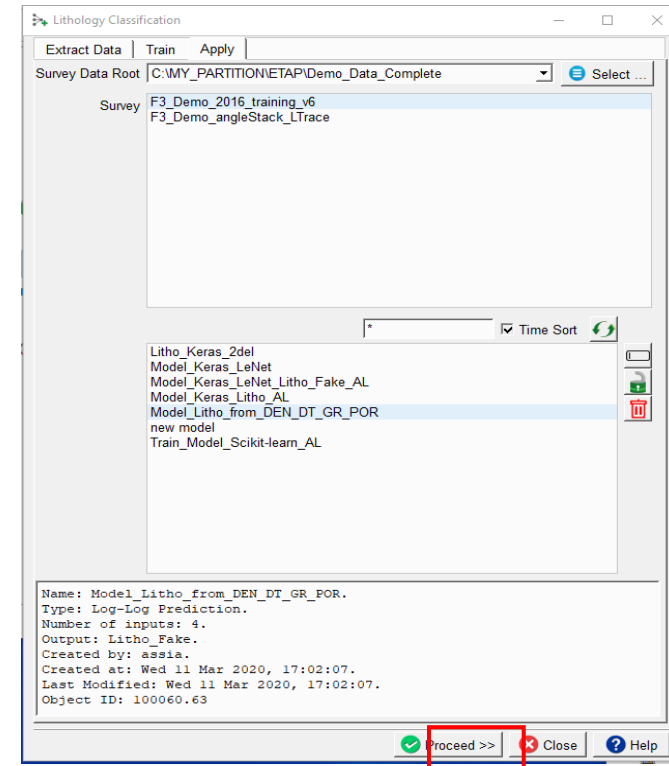
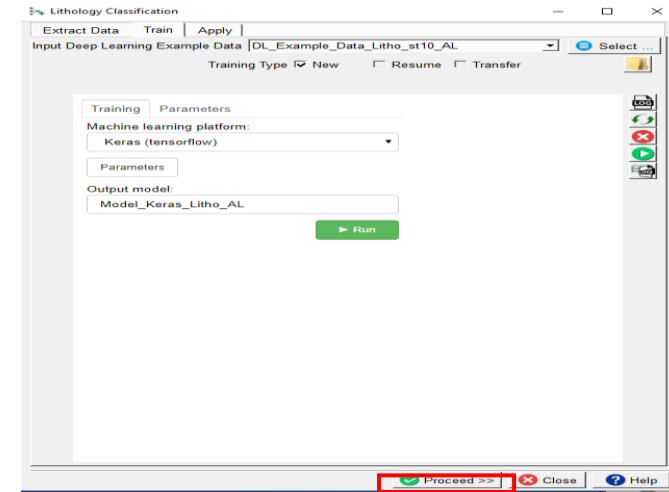


Workflow cont'd:

25. **Press** Proceed in the 'Lithology Classification-Train' Window.
26. "Apply" tab get activated, **Verify** the Survey and Model are correct. Otherwise, modify accordingly.

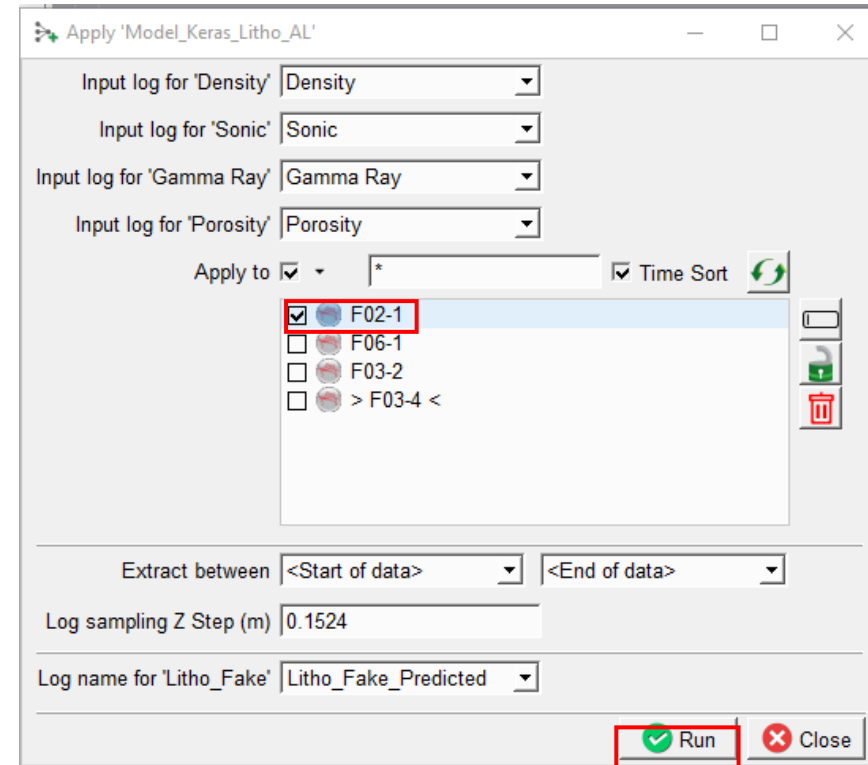
The Survey, Training model can be modified here.

27. **Press** Proceed.




Workflow cont'd:

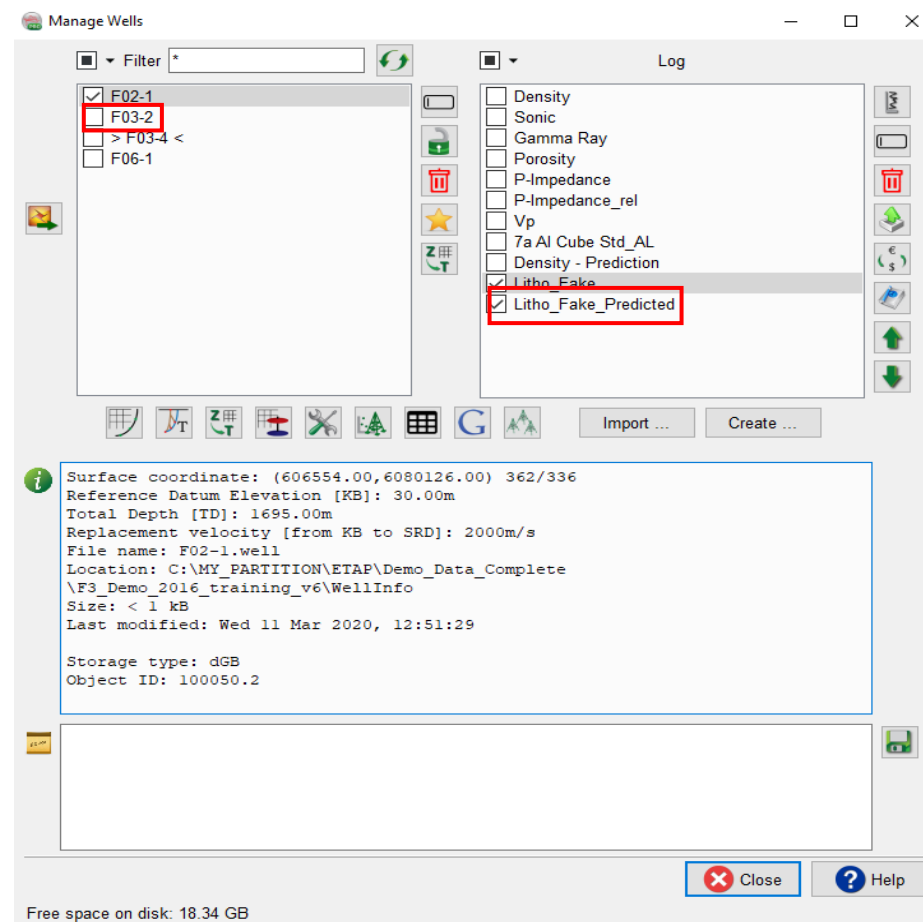
28. The “*Apply* created training model” window pops up.
29. **Apply** the trained model to a blind well (not used in the training process). **Select** F02-1.
30. **Keep** default parameters. **Type** a new Log name for the predicted lithology log “Litho_Fake_Predicted”.
31. **Press Run** to continue.



Workflow cont'd:

QC results by displaying the predicted log adjacent to the recorded log

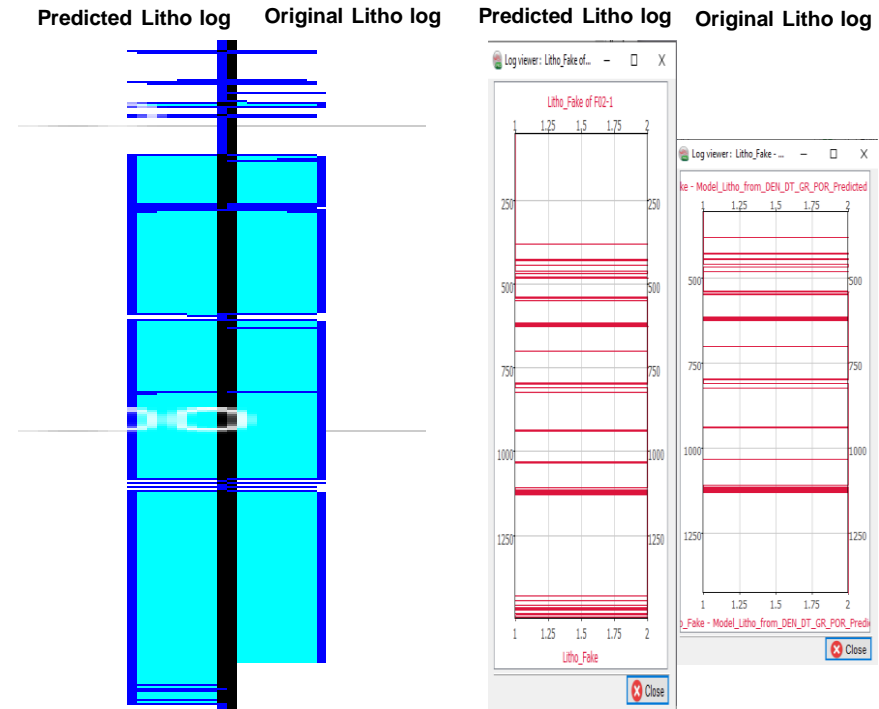
32. **Click** on the Well Manager  icon.
33. **Select** the blind well F02-1, Litho_Fake and Litho_Fake_Predicted logs.
34. **Click** on view logs.



Workflow cont'd:

35. **Compare** the original vs predicted litho-log.

Note: The missing parts at the top and base of the predicted log are due to missing values in the input logs e.g. Porosity.



Workflow cont'd:

If the results are satisfactory, go back to the “Apply training” window, and apply the trained model to all the wells where you want to make predictions.

36. **Select** All Wells. Keep default parameters as indicated in the window.
37. **Press** Run to continue.

Apply 'Model_Keras_LeNet_Litho_Fake_AL'

Input log for 'Sonic' Density

Input log for 'Gamma Ray' Sonic

Input log for 'Porosity' Gamma Ray

Apply to ☒ * ☒ Time Sort

☒ F02-1

☒ F06-1

☒ F03-2

☒ > F03-4 <

Extract between <Start of data> <End of data>

Log sampling Z Step (m) 0.1524

Log name for 'Density' Litho Fake Predicted

☒ Run ☐ Close