Spectroscopic age indicators in dwarf and giant stars

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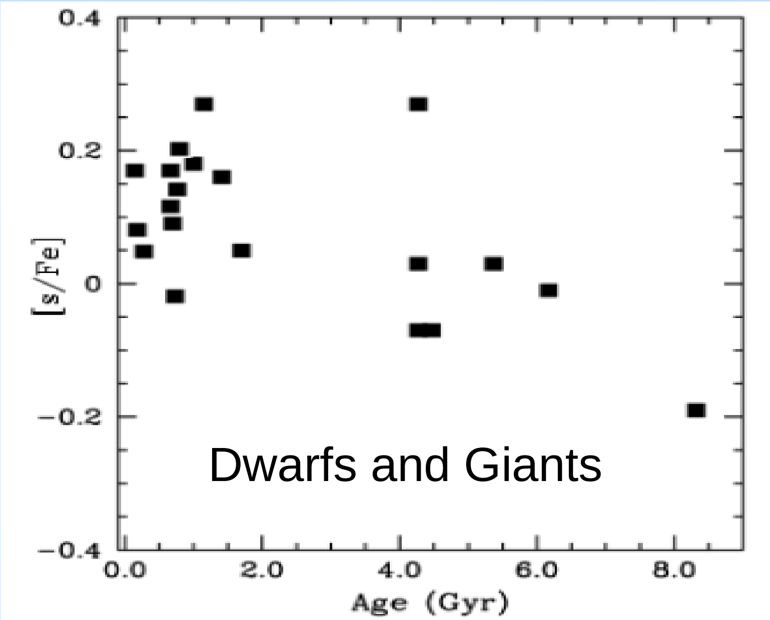
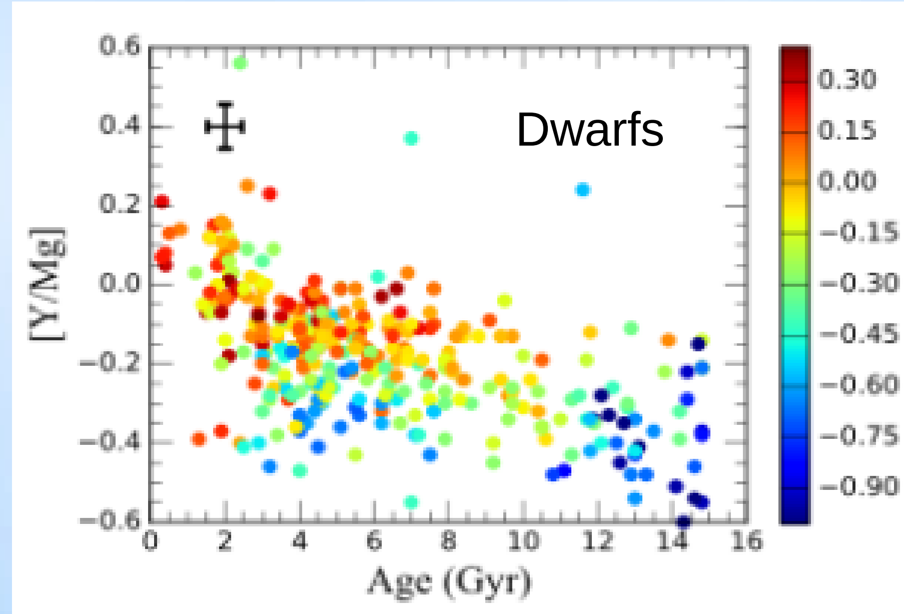
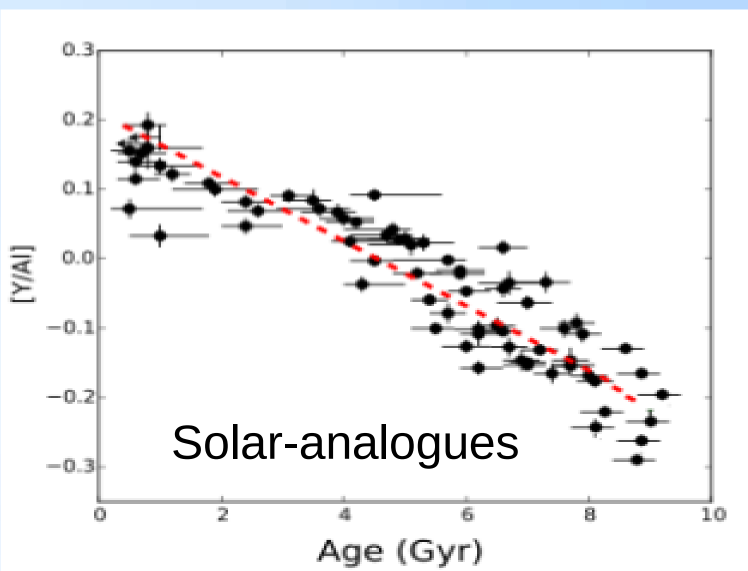
Introduction



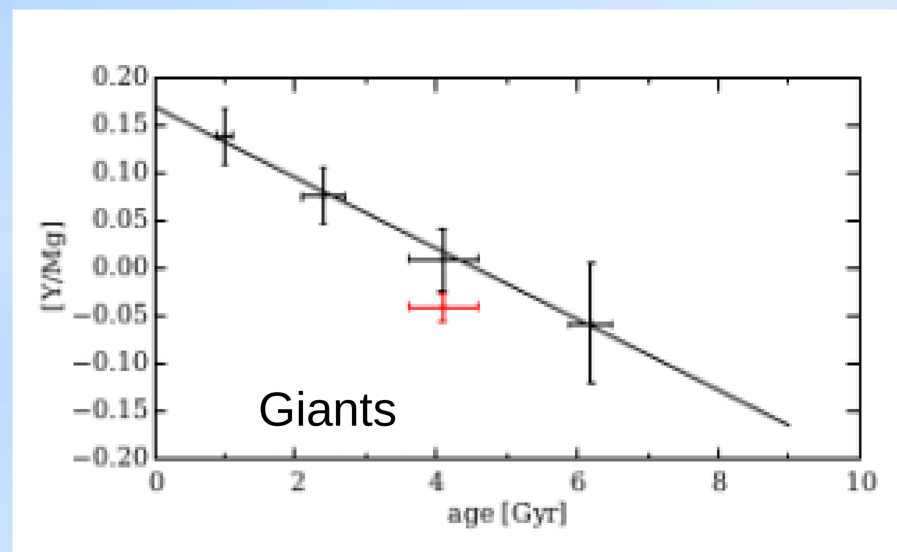
Tendency [s/Fe] vs ages found by Maiorca et al. (2011).
Black squares are giants in open clusters.



Tendency [Y/Mg] vs ages for field dwarf with solar [Fe/H]
Taken from Feltzing et al. (2017).

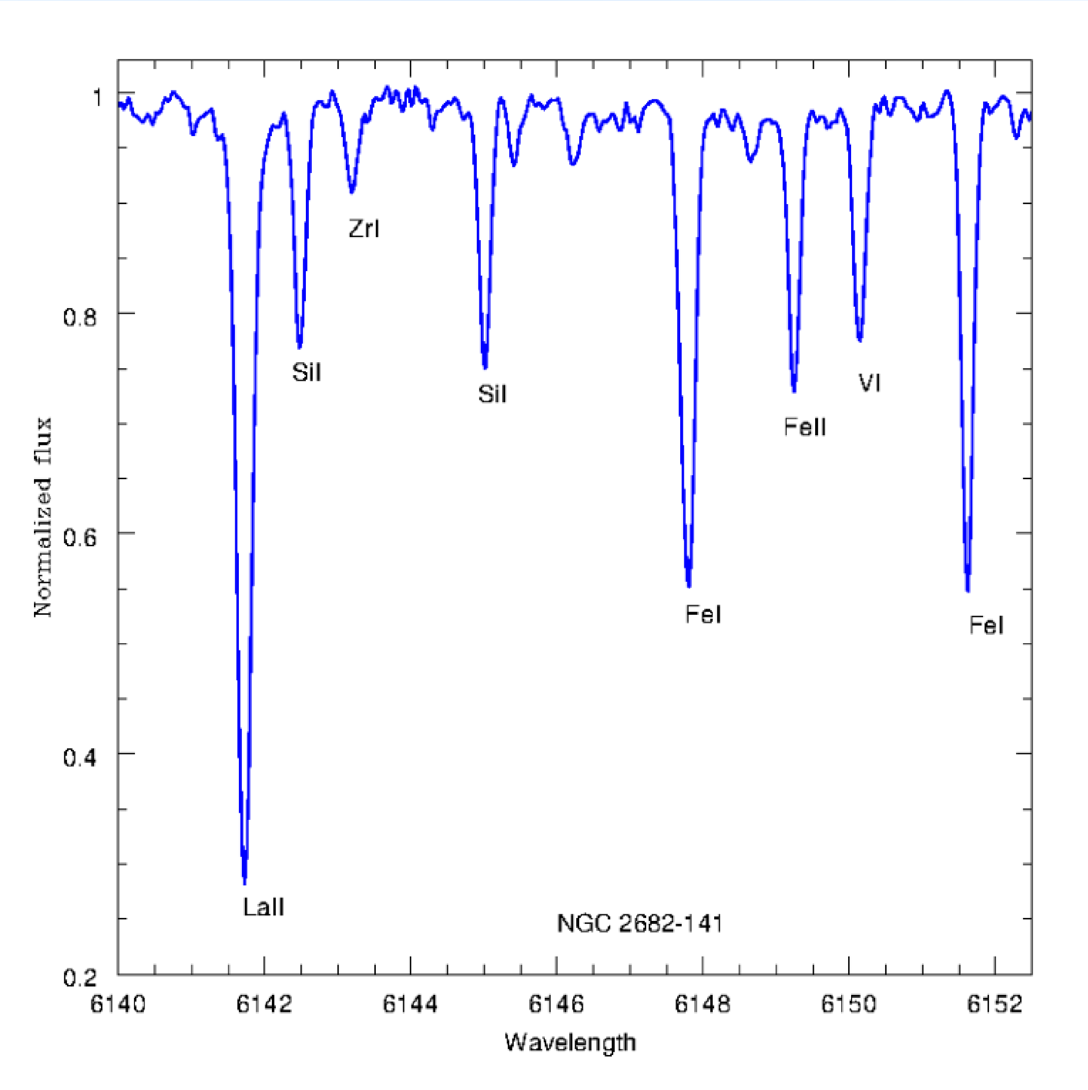


Tendency [Y/Al] vs ages found by Spina et al. (2018).
Black circles are solar-analogues and twins.



[Y/Mg] vs ages found by Slumstrup et al. (2017). Squares represent giants in open clusters. Black line is Nissen (2015).

Spectra and method



Example of FEROS spectrum. Some absorption lines are Identified. EWs measured from splot/IRAF.

ESO archive spectra from FEROS (45.000, 52.000). Observed with 2.2mts MPI/La Silla. (S/N)>120.

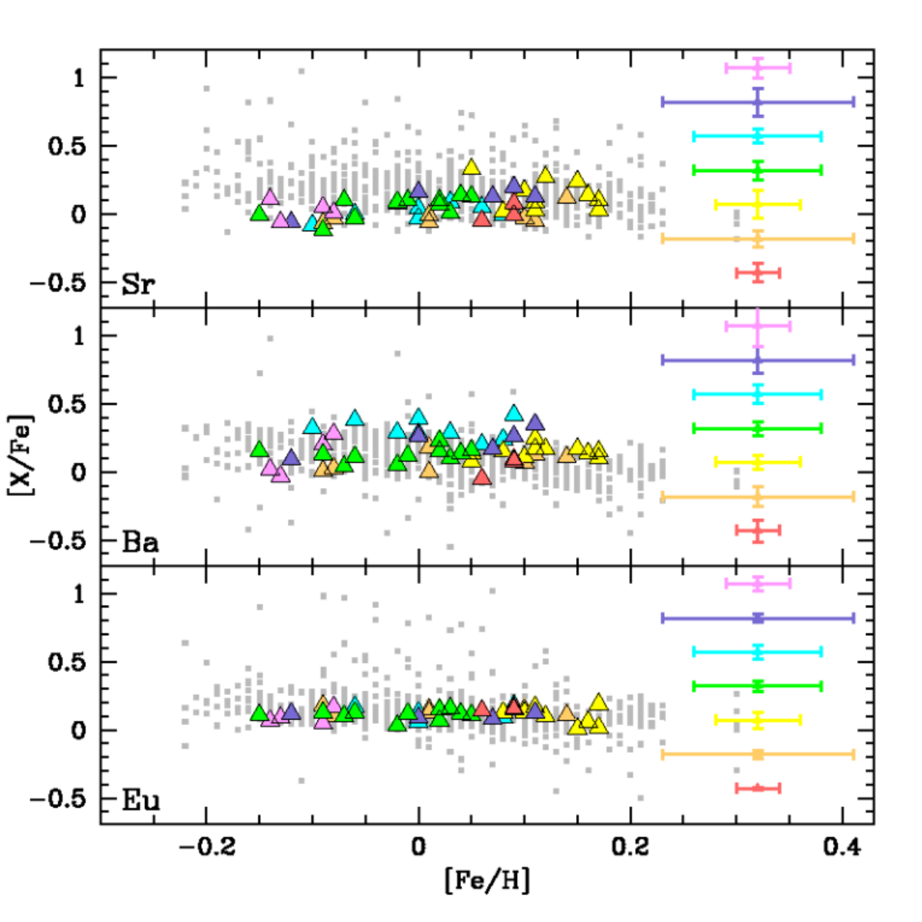
50 spectra of 7 open clusters, also field stars (dwarfs and giants).

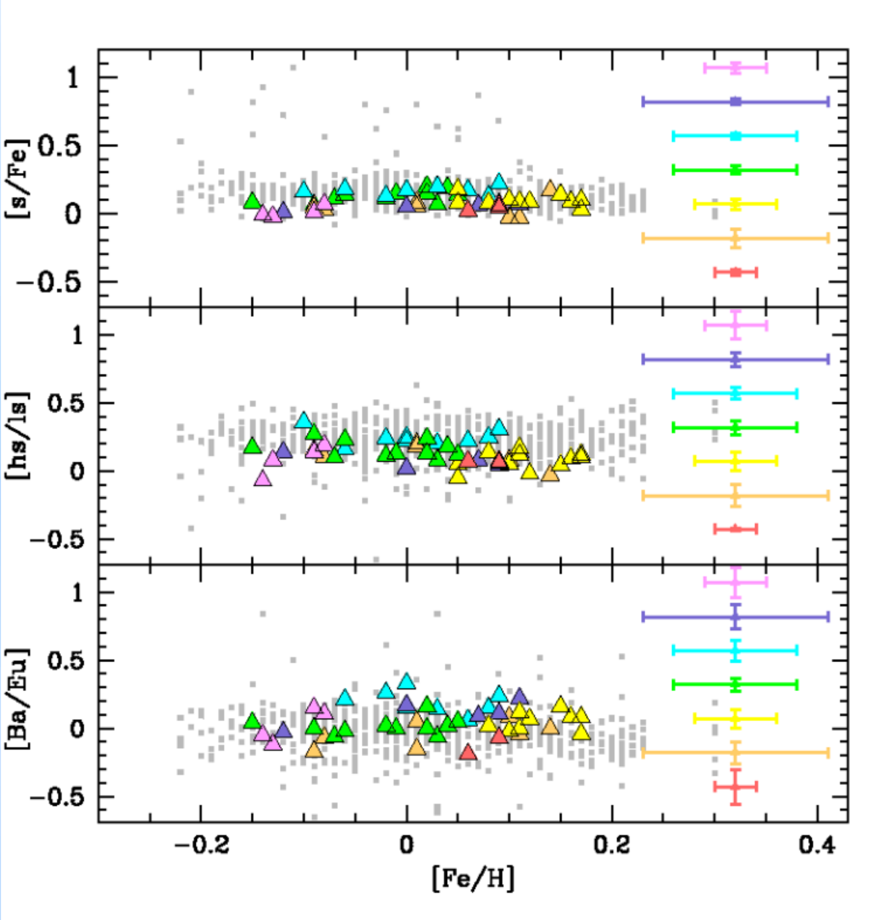
Atmospheric parameters and chemical abundances from LTE-hypothesis:

- Excitation equilibrium for effective temperatures
- Ionization equilibrium for surface gravities
- Microturbulence velocity from A(FeI) vs EW_r=0.00
- atmospheric grids of Kurucz in LTE conditions.
- Elements with hyperfine structure corrections from spectral synthesis technique

SrI, BaII, EuII, [s/Fe], [hs/ls] & [Ba/Eu]

Our abundances are similar to the field and cluster giants studied in literature.
The results fall along the trend of the galactic disk.





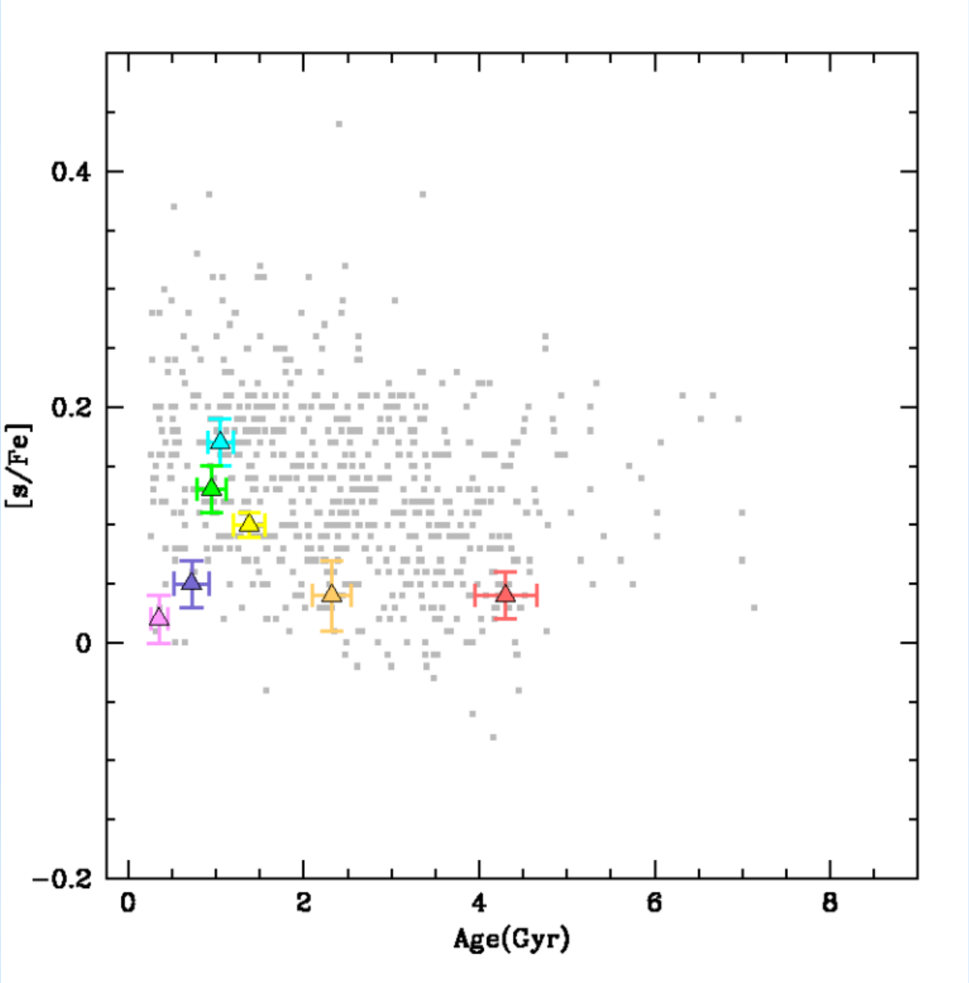
Left: abundance ratios [X/Fe] for SrI, BaII & EuII compared to the field giants. Color triangles: our results; Grey squares: giants of Luck (2015).

Right: [s/Fe], [hs/ls] & [Ba/Eu] compared to the field giants.

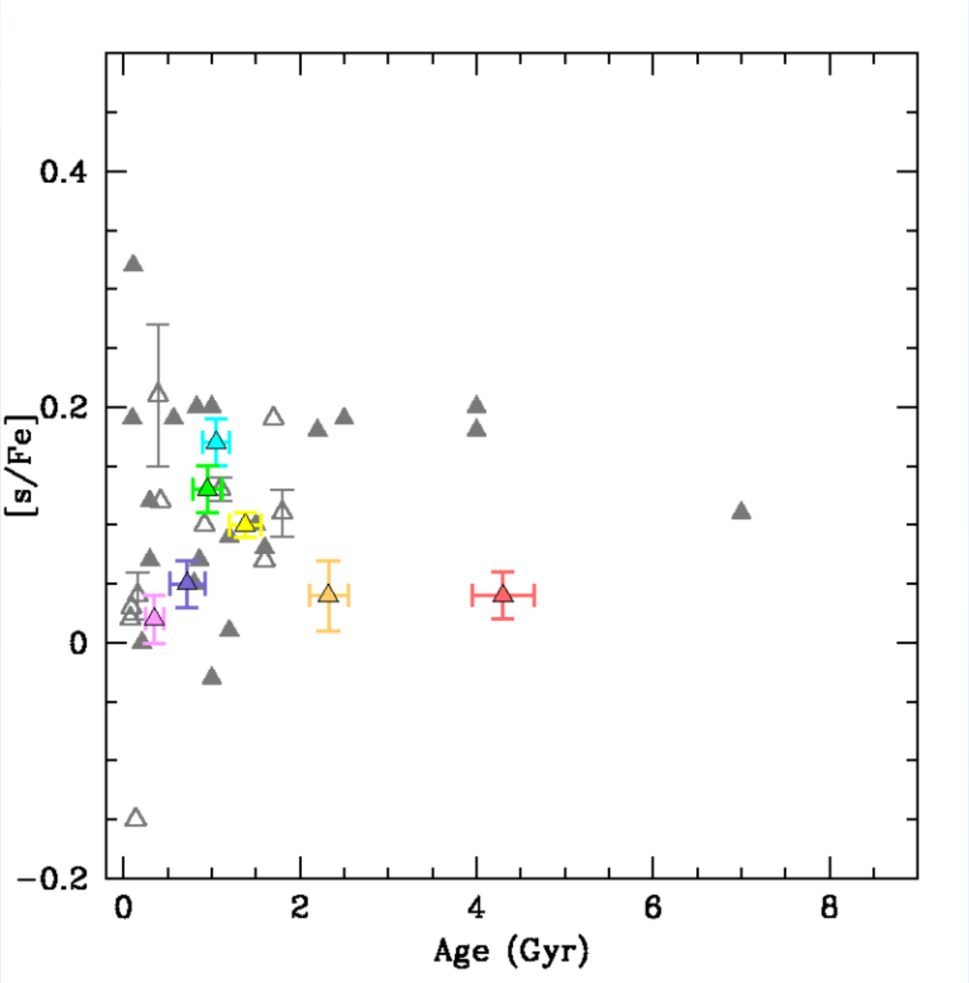
Figures from Katime Santrich et al. (2020, submitted).

Results: clock [s/Fe]

Mean of the s-process (from SrI, BaII, LaII, ZrI, YII, CeII and NdII) has no a tendency with the ages. It is not reproducing the tendency reported in open clusters by Maiorca et al. (2011).



Left: mean values of [s/Fe] vs ages compared field giants. Symbols as last figures.

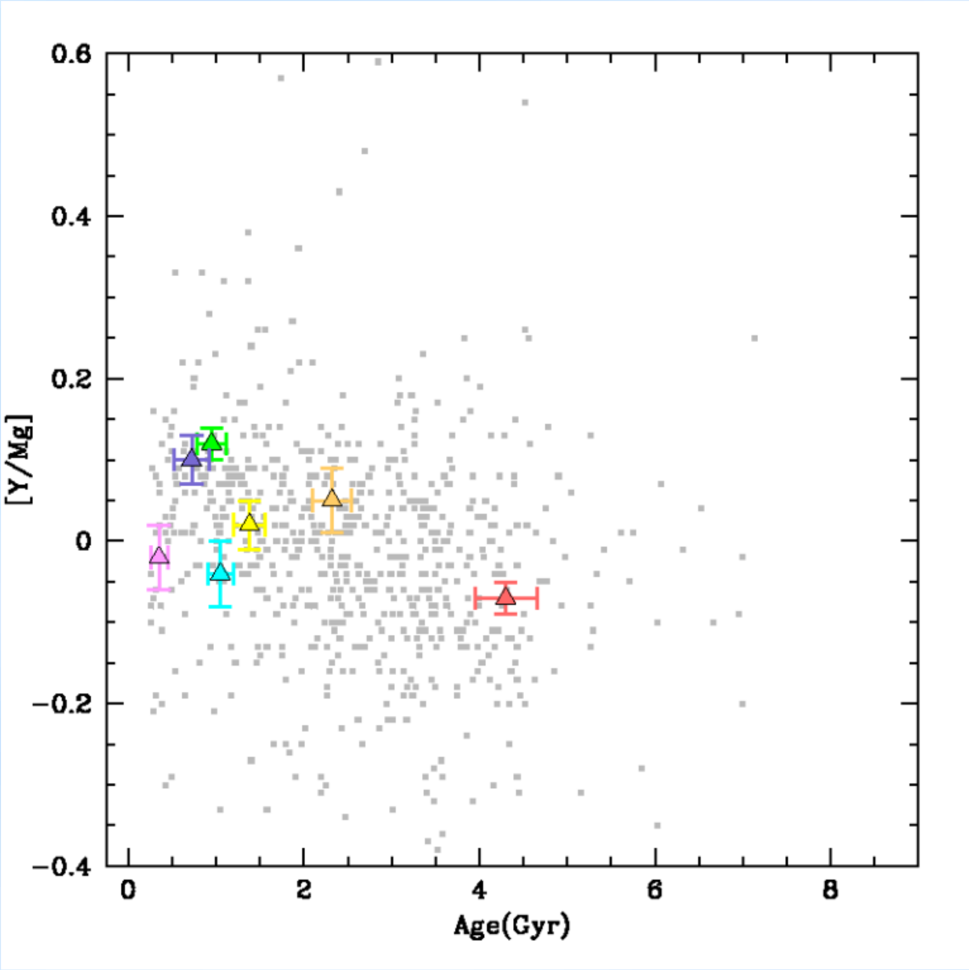


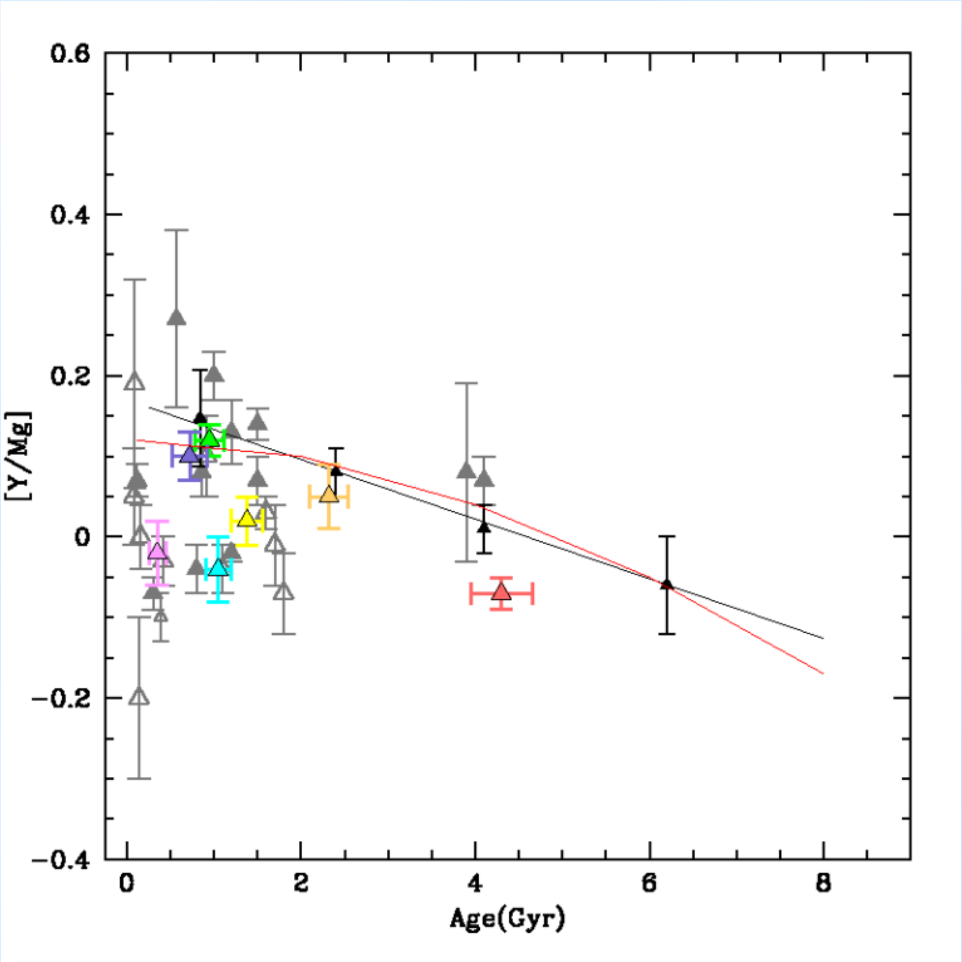
Right: [s/Fe] respect to the open clusters of literature. Symbols as last figures.

Figures from Katime Santrich et al. (2020, submitted).

Results: clock [Y/Mg]

This clock works in solar analogue and dwarf stars but no for giant stars.





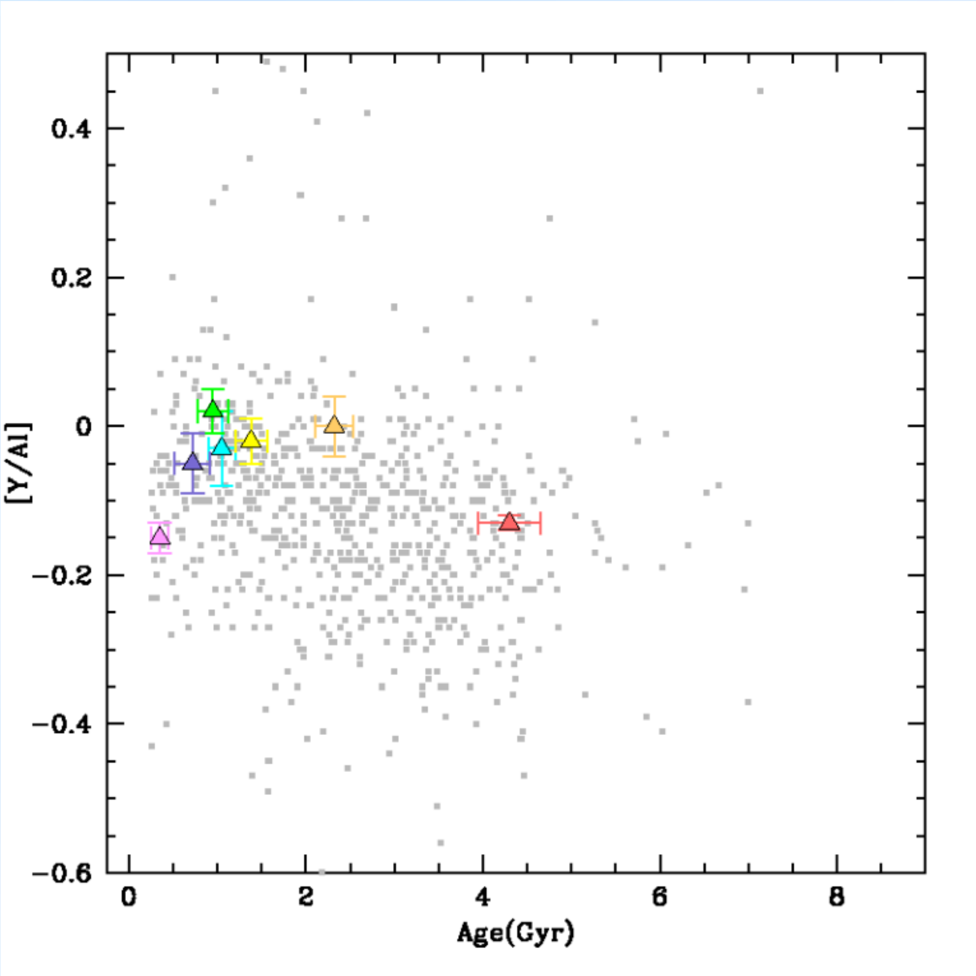
Left: [Y/Mg] vs ages compared to field giants. Symbols as last figures.

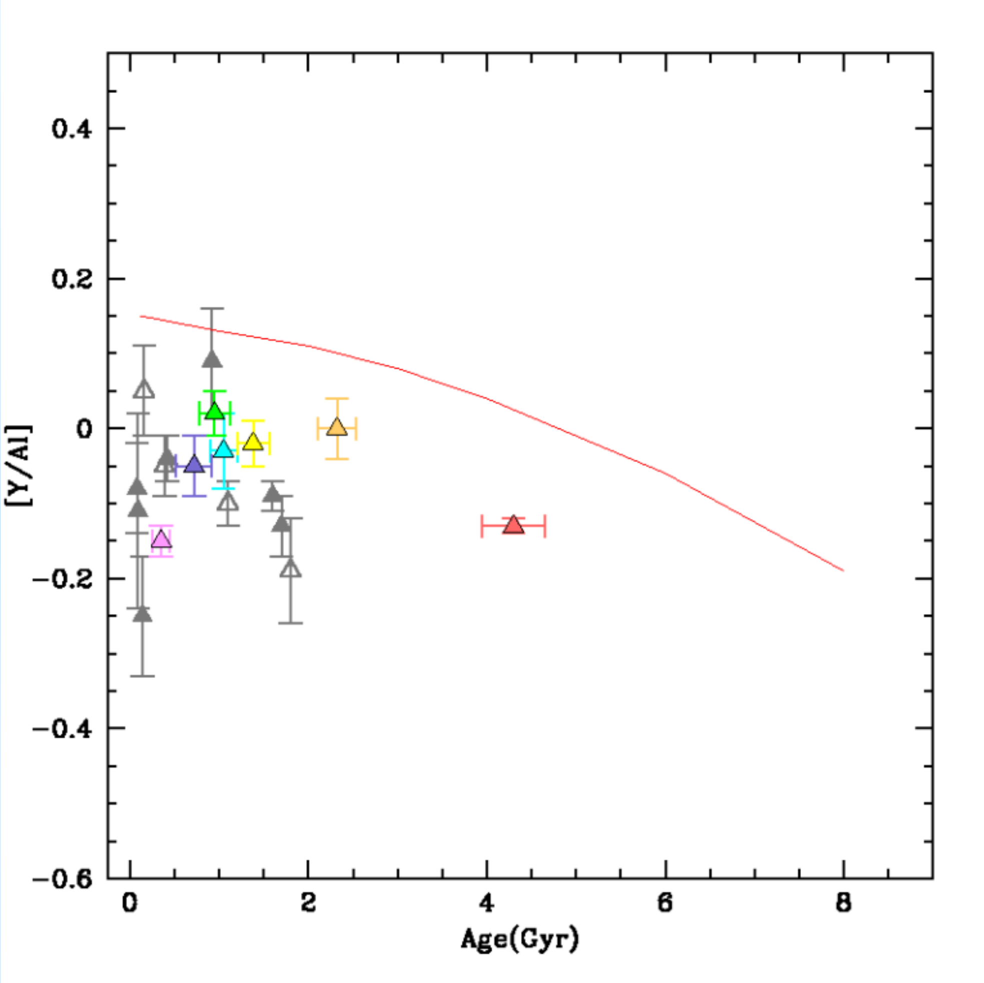
Right: [Y/Mg] vs ages compared to open clusters. Black triangles: Slumstrup et al. (2017); black line: fit of Nissen (2015); red line: Spina et al. (2017). Others symbols as in last figures.

Figures from Katime Santrich et al. (2020, submitted).

Results: clocks [Y/Al]

This spectroscopic clock also does not work for giant stars. It is the same behaviour than [s/Fe] and [Y/Mg].



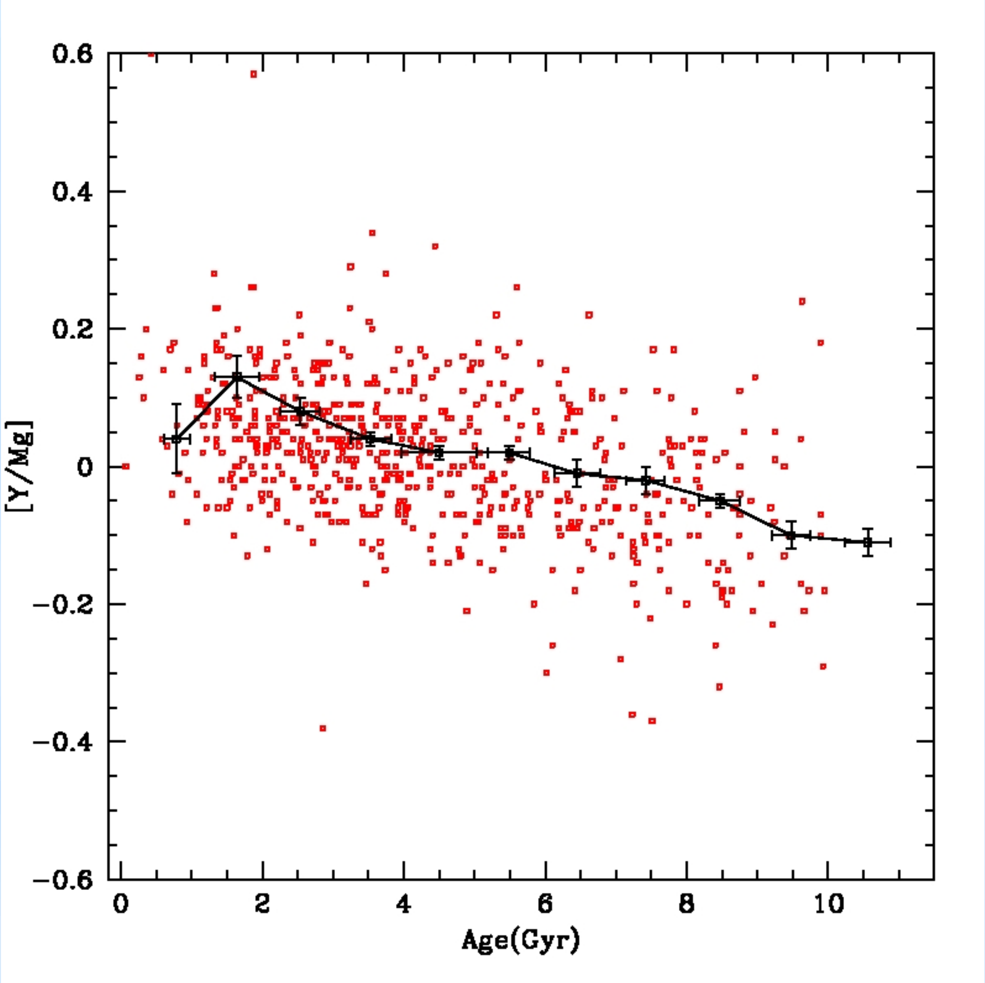


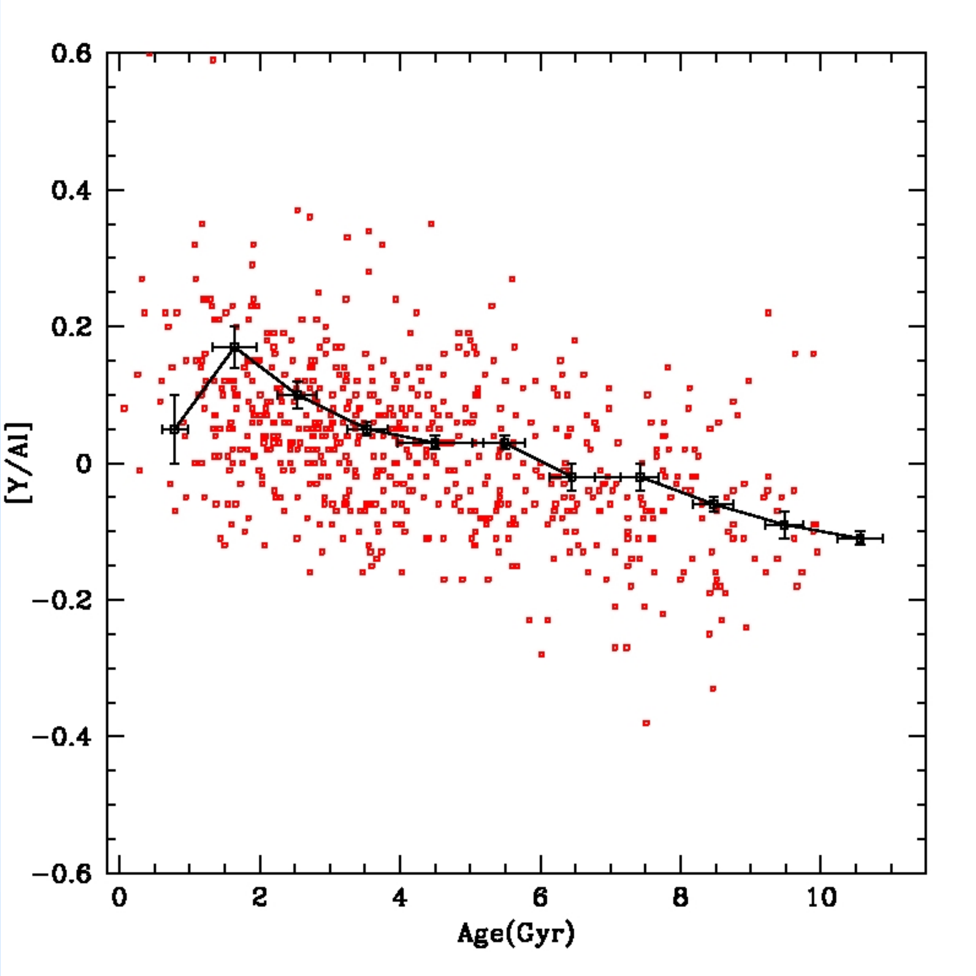
Left: [Y/Al] vs ages compared to field giants. Symbols as in last figures.

Right: [Y/Al] vs ages compared to open clusters. Symbols as in last figures.

Figures from Katime Santrich et al. (2020, submitted).

[Y/Mg] & [Y/Al] in dwarf stars





Left: [Y/Mg] vs ages for field dwarf stars (red squares) of Luck (2018). Black line is the bin-values for each age range.

Right: [Y/Al] vs ages field dwarfs. Symbols as last figure.

Figures from Katime Santrich et al. (2020, submitted).

Conclusions

- [Sr/Fe], [BaII/Fe] & [EuII/Fe] are similar to the galactic disk trend.
- [hs/ls] & [Ba/Eu] shown that cluster sample were formed via main component of the s-process.
- High scattering of the clocks until 2 Gyr.
- Spectroscopic chemical clocks can be used in dwarf stars
- Chemical clocks do not work for giant stars.
- Non-classical extra mixing processes to explain the behaviour in giants.