General comments: The manuscript titled "Soil carbon, nitrogen, and phosphorus storage in juniper-oak savanna: Role of vegetation and geology" is a well-written manuscript that explores how geological factors may interact with woody plant encroachment to influence soil C, N, and P biogeochemistry. The importance of this study is twofold: 1) climate change and certain types of land management are accelerating woody encroachment into grasslands and it's important that we understand how this shift influences soil properties; and 2) it's critical that we understand how geology and vegetation changes interact, as findings can help improve modelling efforts for soil C, N, and P dynamics in various ecosystems going forward. The authors present clear figures and include site photos, which made for a pleasurable read.

Specific comments:

Intro – Well written! May be helpful to include a brief explanation of how the interaction between soil depth and δ13C of SOC can inform us on the history of the landscape (i.e., Fig. 3a). It would help set up your hypotheses, results, and beginning of your discussion section nicely for those who are less familiar with this concept.

Thank you for your suggestions. I propose to add these sentences into L86:

… grass vs. woody sources of soil organic matter. Grass species in the Edwards Plateau generally use C_4 photosynthesis, resulting in different $\delta^{13}C$ values compared to the encroaching woody species, which use C_3 photosynthesis (Boutton et al., 1998). Changes in the $\delta^{13}C$ signatures at different soil depths can reveal historical shifts in predominant vegetation, possibly due to climatic changes, disturbances, or human activities (Jessup et al., 2003; Zhou et al., 2019). We tested the hypotheses that…

Line 109 – can you specify if this higher clay content is across the entire soil profile or across some specific depth?

Thank you for bringing this to our attention. To clarify, I propose modifying the sentence as:

"The clay content in Buda soil is generally 2-5 % lower than that in Edwards soil throughout 0-40 cm profile based on USDA/NRCS data".

Fig 1 – Great idea to include photos of the Edwards and Buda soils. I think it's helps readers better understand the differences between them (i.e., depth).

Thank you!

Lines 127 – 129 - Would be useful to add % forage utilization in parentheses here for context on how 'light grazing' vs. 'heavy to moderate grazing' is being defined.

Thank you for your suggestions. I propose to adjust the sentence as:

"Grazing in this area was heavy (2 - 5 ha/animal unit/yr) to moderate (6 - 8 ha/animal unit/yr) from approximately 1880 to 2010, but the area chosen for this study was grazed lightly (9 - 15 ha/animal unit/yr) and intermittently for the past 10 yrs (Leite et al., 2020). Since 1948, the livestock composition in these grazed areas has maintained an approximate ratio of 60:20:20 for cattle, sheep, and goats, respectively (Marshall, 1995)".

Lines 138 – 139 - Please extrapolate/clarify what you mean by 'within the middle of each depth increment'. I believe you mean 5 cm in the 0-10 cm increment – if you specify this, it will align with the figures better.

Thank you for your suggestions. I suggested to modify the sentence as:

"… We aimed for the midpoint within each specified depth range for sampling. For instance, samples were taken at 5 cm for the 0-10 cm range, 15 cm for the 10-20 cm range, 30 cm for the 20-40 cm range, and so forth. Each sampling point involved the horizontal insertion of two soil cores (7.6 cm width x 10 cm length) into the trench face."

Table 1 & Table 2 – please consider removing lines between rows in the tables. If this is required formatting, then ignore. Otherwise, I suggest removing and formatting according to journal requirements.

Thank you for your suggestions! I have removed the inside horizontal lines.

Lines 172 – 173 – The way this is written throws the reader off a little bit. Please consider rewriting as: "The fraction, (*f*), was the proportion of SOC derived . . ." or something similar.

Thank you for your suggestions. I will modify the sentence as:

The fraction, (*f*), was the proportion of SOC derived from C_4 plants and (1 – f) is the proportion of SOC derived from C_3 plants.

Lines 201 – 202 – If you weren't able to get BD measurements >20 cm for Edwards soils, how were you able to accurately make SOC predictions past 20 cm (Fig. 4a)? From what I recollect, von Haden requires BD for the input sheet and R script.

This is a great question. Indeed we encountered limitations in getting bulk density for Edwards soil beyond 20 cm depth. Thus, we used a cubic-spline extrapolation method to estimate cumulative SOC stocks from 0-40 cm soil layer based on data from 0-10 and 10-20 cm (Wendt and Hauser, 2013). Then, we can get SOC stock within 20-40 cm soil layer based on the difference between cumulative SOC stocks from 0-20 and 0-40 cm soil layers.

Lines 208 – 209 – can you clarify what you mean by . . . "the fact that SIC increased more strongly with soil depth beneath oak than beneath grassland or juniper vegetation". Is this based on the slope of the lines in fig 2d? And is it pertaining to across all depths? Just glancing at the figure, it appears the biggest change in SIC between the first and second depth increment is for grass.

Thank you for highlighting this discrepancy. I recognize that there was an error in my initial interpretation presented in the manuscript. I propose revising the sentence on L208 as:

"… the fact that SIC increased more strongly with soil depth beneath grassland than beneath oak or juniper vegetation (Fig. 2d)".

Table 2 – Very interesting and surprising that depth alone did not significantly affect SOC. Only the interaction between geology and depth. I suggest capitalizing Depth, Vegetation Geology in the table to make the abbreviations even more intuitive.

Thank you for your suggestions. I will capitalize Depth, Vegetation Geology in Table 2.

Fig. 3a – I like the inclusion of δ13C litter values in the same figure as δ13C soil values. However, I would add a statement indicating exactly what the dashed line on the figure indicates in the figure caption for further clarity.

Thank you. I propose the following modification to the captain of Figure 3:

"Changes in (a) $\delta^{13}C$ of litter (above dashed line) and soil, and (b) the fraction of SOC derived from C_4 grass beneath juniper and oak in soils derived from the Buda vs. Edwards formations calculated using mass balance. Results are given as means ± standard errors of the mean. Data are plotted at the midpoints of the depth increments."

Line 244 – perhaps change to … "while **only** oak had higher SOC and TN on Buda soils". It reads a little easier that way.

Thank you. I agree to revise the sentence as:

" Soils beneath live oak and Ashe juniper had higher SOC and TN than grasslands throughout the profile on Edwards soils, while only oak had higher SOC and TN on Buda soils (Figs. 4a and c)."

Line 306-307 – is it plausible that higher clay content in the Edwards soil could have increased soil C relative to Buda as well? You make a point in the methods that the Buda soil has less clay content.

Thank you. You are correct that differing clay contents between the Edwards and Buda soils could influence the respective carbon storage capacities. I propose revising the sentence on L306-307 as:

We speculate that the higher concentrations of C, N, and P in soils atop the Edwards limestone could be attributed to two factors: First, the higher clay concentration which offers a higher C storage capacity (Basile-Doelsch et al., 2020; Six et al., 2002) and second, the shallow depth to bedrock (approximately 40 cm) in Edwards soil that constrains root and litter inputs to a limited soil volume.

Discussion – towards the end of the discussion, it would be helpful to briefly address other ecological effects of woody encroachment that were not directly measured in this study (i.e., biodiversity, soil erosion, etc.). It would make sense to add this sentiment after your point about SIC loss with encroachment (line 347).

Thank you for your suggestion. We recognize the importance of these aspects; however, we believe that including a detailed discussion on topics such as biodiversity and soil erosion might shift the specific focus of our manuscript, which aims to elucidate the interactions between geological factors and woody plant encroachment concerning soil C, N, and P biogeochemistry. Nevertheless, understanding the significance of these points, we propose two potential approaches to acknowledge these important ecological contexts without deviating from our core findings:

1. Within the Discussion section, we could subtly integrate these points as an additional paragraph following section 4.3 Soil stoichiometry. Here's a proposed addition:

   "Recognizing that the altered soil nutrient dynamics have far-reaching ecological consequences, the woody encroachment phenomenon might extend beyond biogeochemical changes. For instance, the modification of microclimatic soil conditions and suppression of herbaceous diversity under woody canopies could influence broader biodiversity (Archer et al., 2017). Furthermore, the disparity in soil nutrient availability between soils under canopies and nutrient-deprived interspaces

(Figs. S1 and S2) may escalate the risk of soil erosion (Puttock et al., 2014; Ravi and D'Odorico, 2009). These considerations, while beyond the primary scope of our current investigation, highlight the multifaceted impacts of woody plant encroachment on arid and semi-arid ecosystems."

2. Alternatively, we could condense these ecological effects and incorporate them into the first paragraph in the Introduction.

Either way, we appreciate your guidance on whether a broader context in the Discussion or a brief mention in the Introduction would be more appropriate, or if another approach might better serve the manuscript.

Conclusion – As is, the conclusion is quite long. Please distill and shorten where appropriate – focus on **what** was found and **why** it's important.

Thank you for your suggestions. I suggest to rewrite the Conclusion as:

This study investigated the impact of *Juniperus ashei* and *Quercus virginiana* encroachment on soil C, N, and P stoichiometry in mixed grass prairies on the Edwards Plateau of central Texas, considering the influence of underlying geological variations between soils lying atop two different limestone parent materials – the Buda vs. Edwards formations. Stable C isotope ratios ($\delta^{13}C$) of soil organic matter revealed that 45-90 % of soil C in the 0-40 cm depth interval beneath juniper and oak stands was derived from C_4 plants, confirming that these woody plants were recent components of the landscape. Vegetation and geology interaction significantly influenced soil C, N, and P levels, with higher values under juniper and oak canopies than grasslands and on soils derived from the Edwards formation, possibly due to higher clay content and limited soil volume due to shallow depth to bedrock (approximately 40 cm). Conversely, the deeper Buda formation (> 1 m) allowed more extensive root and litter distribution, resulting in lower element concentrations. Soil C:N, C:P, and N:P ratios were generally higher under woody plant canopies compared to grasslands, indicating that woody encroachment increased SOC and TN relatively more than TP. While C and N consistently increased — likely because of their close linkage during primary production, respiration, and decomposition — P trends deviated, reflecting influences from geochemical processes. Our results are broadly consistent with prior studies around the world showing that woody plant encroachment into arid/semiarid ecosystems generally results in increased concentrations and pools sizes of soil C, N, and P, as well as changes in their stoichiometric relationships. Our study also suggests that the magnitude of these changes may be influenced by attributes of the geological formations that underly the soil. Given the geographic extent of woody encroachment at the global scale, our results have important implications for the management and conservation of these ecosystems. We suggest that interactions between vegetation changes and geology warrant consideration in future studies and could play a role in efforts aimed at improving the prediction and modeling of soil C, N, and P storage in grasslands, savannas, and other dryland ecosystems.