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# Interpretive field geomorphology as cognitive, social, embodied and affective epistemic practice

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## Abstract

This article examines the epistemic practices of interpretive field geomorphology—that is, the in-the-moment act of “seeing the landscape” geomorphologically. Drawing on the philosophical works of Wittgenstein and Merleau-Ponty, it aims to bring to light the complex, multi-dimensional, knowledge-producing process of field observation and interpretation. Methodologically the study is based on geomorphologists' accounts of their fieldwork, gathered through questionnaire and interviews. By paying attention to what geomorphologists say they are doing in the field, interpretive field geomorphology is articulated as a combined cognitive, social, embodied, and affective experience through which understanding is arrived at. The paper thus sheds light on one part of what Brierley et al. call “the dark art” of geomorphological interpretation, and draws out implications in terms of researcher positionality, researcher training, and offering an epistemic justification for field-based pedagogies.

## KEYWORDS

epistemology, fieldwork, geomorphology, geomorphological interpretation, “seeing the landscape”

## Résumé

Cet article analyse les pratiques épistémiques de la géomorphologie interprétative de terrain—c'est-à-dire l'acte, dans le moment présent, de « voir le paysage » dans une perspective géomorphologique. En s'appuyant sur les travaux philosophiques de Wittgenstein et Merleau-Ponty, nous cherchons à mettre en lumière le processus complexe, multidimensionnel et producteur de savoir de l'observation et de l'interprétation de terrain. Sur le plan méthodologique, l'étude se base sur les récits de géomorphologues au sujet de leur travail de terrain, propos recueillis par le biais de questionnaires et d'entrevues. En prêtant attention à ce que les géomorphologues disent faire sur le terrain, la géomorphologie interprétative de terrain se révèle comme expérience totale, c'est-à-dire à la fois cognitive, sociale, incarnée et affective, à travers laquelle la compréhension est atteinte. L'article jette ainsi la lumière sur une partie de ce que Brierley et al. appellent « l'art obscur » de

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l'interprétation géomorphologique, et en tire des implications en termes de positionnement et de formation des chercheurs, tout en offrant un fondement épistémologique aux pédagogies de terrain.

#### MOTS CLÉS

géomorphologie, travail de terrain, épistémologie, interprétation des paysages, « le regard géographique »

#### Key messages

- Interpretive field geomorphology is an epistemic practice entailing social, bodily, and affective dimensions.
- Researcher positionality includes prior experience of interpreting landscapes and doing so with others.
- Field experience contributes to both development of skill in geomorphological interpretation and development of understanding, which is more than just cognitive.

## INTRODUCTION

Physical geography fieldwork entails more than is written into the publication of results. Being-in-the-field is a multi-dimensional, cognitive, socio-cultural, corporeal, affective experience that is filtered in order to arrive at the propositional knowledge that counts as science (Harden, 2013; Phillips, 1999; Trudgill, 2003). This paper offers an expanded account of the epistemic practice of geomorphological field interpretation, using geomorphologists' accounts of their fieldwork experiences to articulate aspects of geomorphological fieldwork that are usually invisible. In doing so, it contributes to: i) the understanding of research processes necessary for the continued development of critical physical geography; and ii) the articulation of the role of fieldwork in physical geography education and researcher development.

The development of critical physical geography (Lave, 2014; Lave et al., 2014; Lave, Lane, & Biermann, 2018) necessitates attention to the processes and practices of knowledge production in physical geography. Tadaki (2017) notes that the “critical” of critical physical geography often takes one of two forms: either being critical *in* environmental science, concerned with questions of method, evidence, logic, and truth claims; or being critical *of* environmental science, attending to the social and political contexts that shape scientific practices. While the former “brackets out” the social, the latter overlooks the agency of individual scientists. Examining field geomorphology through the experiences of individual geomorphologists draws attention to the individual and collective (socially shaped, disciplinary) epistemic practices at work. It thus holds potential to contribute to the development of Tadaki's suggested third form of criticality: being critical *through* science.

Specifically, this paper addresses interpretive field geomorphology, the practice of making sense of observations in the field sometimes termed “seeing the landscape.” Brierley et al. (2021) offer a detailed account of “the dark art” of landscape interpretation in geomorphology, drawing out the multiplicity of cognitive aptitudes and processes, forms of evidence and reasoning that come together in arriving at interpretation. Interpretive field geomorphology is one small part of this process: the in-the-moment act of making/processing observations in the field.

At various times geographers and others in cognate disciplines have felt a need to justify the centrality of fieldwork, often in response to perceived threat. In the United Kingdom, structural changes to higher education in the early 1990s prompted such response (Clark, 1996; Higgitt, 1996; McEwen, 1996; McEwen & Harris, 1996). The advent of big data and associated computational capacities are sometimes viewed in a similar manner (Fonstad & Zettler-Mann, 2020), although to Brierley et al. (2021) different approaches to geomorphology are complementary rather than in competition. The COVID-19 pandemic impacted on fieldwork for both research (Oliver, 2022) and teaching, with virtual fieldwork rapidly proliferating (Bryson & Andres, 2020; Howlett, 2021; Li et al., 2022; Mercer et al., 2022; Rose-Redwood et al., 2020; Yoon & Mecca, 2022). Geographers' repertoire of methods has expanded, Guasco (2022) arguing that geographers should always justify *doing* fieldwork, just as much as she felt obliged to justify *not* doing fieldwork. In education, such justifications often refer to student outcomes. Attending to the way geomorphological knowledge is developed in the field, this paper identifies value in epistemic and pedagogical processes of fieldwork—a value that may be easily overlooked in outcomes-focused educational systems.

To proceed, an outline of writing on geographical/geomorphological fieldwork is followed by explanation of researcher positionality, conceptual framing, and methods. The paper then progresses through the practices of making sense of geomorphology in-the-field, before considering implications of the resulting understanding of interpretive field geomorphology.

## ON FIELDWORK IN GEOMORPHOLOGY

Geomorphology's position straddling geography and geology (Twidale, 1999) and intersecting other environmental/geoscience disciplines (Bauer, 1999) means a substantial body of fieldwork literature exists. Relevant themes are drawn out here.

A prominent strand of writing on fieldwork emphasizes its socio-cultural contexts. Undergraduate field trips have been described as a disciplinary initiation ritual (Rose, 1993) through which geographers learn "to act and think like a geographer" (Nairn, 1999, p. 273). Feminist critiques have highlighted that for too long this has meant learning to act and think like a white, male, young, able-bodied, cis-hetero, middle-class European or Anglo-American (Bracken & Mawdsley, 2004; Dosu, 2021; Hall et al., 2002; Kobayashi, 1994; McEwan, 1998; Mol & Atchison, 2019; Olcott & Downen, 2020). Little seems to have changed, with calls for more inclusive fieldwork practices still necessary (Chiarella & Vurro, 2020; Giles et al., 2020; Lawrence & Dowey, 2021; Lininger et al., 2021; Stokes et al., 2021). Such concerns, while important, are not the focus of this paper. However, these critiques of fieldwork are relevant in foregrounding that scientific production of knowledge has historically been framed as objective and disembodied, privileging the visual over other bodily capacities (Nairn, 1999).

While observation has been important in science as far back as ancient Greece (Legleiter & Marston, 2013; Montgomery, 2013), geomorphology as a discipline emerged through the expeditions of Powell, Gilbert and others in late-1800s America, rendering field observation foundational (Rhoads & Thorn, 1996). William Morris Davis (1902) emphasized the importance of field-based learning in physical geography, arguing that students' early fieldwork should focus on observation. This epistemic privileging of observation, critiqued within Geography more broadly (Rose, 1993), has been so central to geomorphology that Rhoads and Thorn (1996) noted it went largely unquestioned.

Field observation is, though, a learned, specialized skill (Bauer, 1999; Brierley et al., 2021; Couper & Ansell, 2012; Vitek, 2013). Davis (1902, p. 239) was clear that observation is not just about "seeing," but "must be followed by abundant thinking." Not all would agree with the implied linearity. Since the mid-twentieth century, geomorphological observation has been recognized to be theory-dependent, our observations shaped by what we expect to see (Blue & Brierley, 2016; Brierley et al., 2013; Burt, 2003; Rhoads & Thorn, 1996; Trudgill, 2003). Observing already involves interpretation; the act of deciding what to observe, an act of filtering (Tuan, 2001).

Being theory-dependent, this filtering is shaped by what the researcher brings to the act of observing. Frodeman (1995, p. 963), drawing on Heidegger's hermeneutics to analyze reasoning in geology, identifies three types of "forestructures of understanding" that shape interpretation:

- i) preconceptions: ideas and theories that shape thinking about an object, opening up some possibilities for understanding while closing off others;
- ii) foresight: the goal of observations and enquiry; and
- iii) fore-having: culturally acquired skills, tools and institutions constituting the set of practices the scientist brings to their enquiry.

These forestructures of understanding become "sedimented into" the scientific record, shaping enquiries in ways such that some things are discovered rather than others. Latour's (1999) account of soil science in the Amazon identifies a range of instruments or technologies—maps, quadrats, augurs, sample bags, classification keys—that sequentially abstract from the complexities and materialities of the field site. Again, filtering is at work, effected through processes of sampling, measuring, and recording.

Contrasting with this emphasis on filtering, another strand of writing on fieldwork (Couper & Ansell, 2012; Dewsbury & Naylor, 2002; Forsyth, 2013; Lorimer, 2003) draws on human geographies of embodiment and affect to articulate the more-than-human entanglements of fieldwork. Emphasizing science as an activity or practice rather than representation (Dewsbury & Naylor, 2002), such work highlights that fieldwork is always a relational act of co-production, shaped by the materialities of the field site as well as by the researcher (Marr et al., 2022).

## "FIELDWORK STORIES" AS METHOD

The project from which this paper stems derives from personal experience of fieldwork in geomorphology, through which I became very conscious of aspects of fieldwork left unwritten in the journal articles reporting research findings. From the mid-2000s, as my research and teaching shifted beyond geomorphology, I developed familiarity with philosophy and theory seemingly relevant for understanding these dimensions. The project from which this paper arises aimed to explore these aspects of geomorphologists' field experience. As a researcher I thus have both insider and outsider status: familiar with geomorphological terminology and practices, but not currently active in geomorphological research, although still teaching some geomorphology at lower undergraduate level.

The conceptual starting point combines strands of philosophy and human geography. Wittgenstein's later work, in the *Philosophical investigations* (1953) and *On certainty* (1974), understands language and knowledge as always embedded in our social and material lives. Geomorphology can be understood as a "language-game": a particular way of using words and making judgments that is socially agreed yet grounded in the empirical reality of the world. Our understanding is dependent on the language-games with which we are familiar. Some take this as a relativist or social constructionist epistemology (Bloor, 1983), but such interpretation overlooks the direct connection between our

language and our actions, a connection that means language-games, and hence meaning, are constrained by the nature of the world around us (Phillips, 2003; Scheman, 1996; Sluga, 1996; Smeyers & Marshall, 1995; Westphal, 2005). In this sense, Lave, Biermann, and Lane's (2018) explanation of critical physical geography's epistemic commitments as mid-way between absolutist and relativist/constructivist notions of truth aligns with Wittgenstein's work.

Merleau-Ponty's phenomenology (1962; 2003) centres the body as the locus of human being-in-the-world and perception. We understand the world through our bodies, and understand our bodies through (interaction with/in) the world. This is not to deny representations and language a role in shaping our understanding of the world, but acknowledges a "preconceptual sense-making" (Taylor 2004, p. 46) in our bodily entanglement in the world. Non- or more-than-representational human geographies (Thrift, 2008) and more-than-human geographies (Whatmore, 2006) similarly pay attention to embodied, affective, and relational dimensions of everyday life.

Methodologically, the research was exploratory, seeking to elucidate the complexities of field research rather than identify statistically dominant themes (Crouch & McKenzie, 2003). Aiming to elicit participants' accounts of their field experiences in their own terms, without imposing the theoretical framing on the data collection phase, the project invited geomorphologists to "tell their stories" of fieldwork in research and teaching (as relevant to each participant). An online questionnaire comprised open questions, beginning with "Tell me about a recent experience of fieldwork." Invitation to participate was disseminated via the "IAG Geomorphlist" international mailing list and Twitter. Respondents had the option to volunteer for follow-up interview. The interviews were semi-structured, aiming to enable participants to talk freely about their experiences. Interviews began with the question "Think about your most recent experience of research fieldwork: can you tell me about it?" This opening question gave participants free rein in choosing what to tell and how to tell it (Scheibelhofer, 2008). Subsequent questions were similarly phrased, with participants' questionnaire responses used as prompts for further storytelling, "You mentioned in the questionnaire ..., can you tell me more about that?" Interviews were held online via MS Teams during 2020, recorded, and transcribed for analysis. Interviews lasted between 34 and 58 minutes each.

Data analysis used coding. Codes were initially concept-driven, derived from the theoretical framing of the project, but then refined through engagement with the data, as is common in coding analysis (Gibbs, 2021). This opened up the analysis in unanticipated ways, examples being the social nature of field interpretation articulated here, or highlighting the presence of "emotion work." Generation of a codebook ensured consistency in deployment of codes throughout the analysis. Woolf and Silver's (2018) distinction between "strategy" and "tactics" of analysis was broadly deployed, for identifying goals and associated specific analytical tasks. Completion of those tasks used NVivo where relevant, although no part of the analysis was automated. For this paper, the empirical data were combined with theoretical insights to construct an account of field interpretation practice. This account was then tested against the data, re-reading all questionnaire responses and interview transcripts in a search for counter-evidence, to ensure robustness.

This is a small-scale study, as is common to qualitative research seeking in-depth understanding of the complexity of a phenomenon (Crouch & McKenzie, 2003). A total of 39 useable questionnaire responses were generated, with 14 interviewees. Interview participants were mixed gender, ranging from postgraduate Masters' and Doctoral researchers through to retired professors, and located in a variety of academic, consultancy, and governmental organizations. Geographically, they were based in nine countries across five continents, with none from Asia and quite strong representation from North America. While some participants are multi-lingual, the research should be understood as situated within, and thus illuminating practices of, Anglophone geomorphology.

Publishing a study involving academics as participants requires careful attention to maintenance of participant anonymity. Empirical evidence is presented here in the form of quotations from participants. Any reference to locations, methods, or findings that may identify participants via their research has been removed. Participants themselves are identified only by number: QX where a respondent only took part in the questionnaire phase of the study; IY/QY or QZ/IZ where they took part in both. In the latter case, the source of quotation (questionnaire or interview) is the first-listed. For example, I10/Q15 and Q15/I10 are the same individual, the quotation source being interview in the first case and questionnaire in the second.

## SEEING GEOMORPHOLOGICALLY

Seeing a landscape geomorphologically entails a move from perceptual experience, the optical dimension of seeing, to interpretation, the semantic dimension of seeing—in other words, reading signs. The basic semiotic categories of "signifier" and "signified" thus offer a starting point to understand how seeing geomorphologically works in practice. Geomorphologist Victor Baker (2000) similarly positions this as a semiotic act, but here I particularly pay attention to what geomorphologists say they are doing in the field when reading signs, to understand the practices through which that act is fulfilled.

Table 1 groups the kinds of objects that, in participants' descriptions of their fieldwork, can be understood as signifiers. Unsurprisingly, materials and form feature strongly, although signifiers are not limited to these. To access these perceptual experiences, participants described a variety of activities: walking is particularly popular, but descriptions included sitting on a rock, standing on a riverbank, sometimes consciously using all senses, including taste. The body is the instrument of observing in the field.

**TABLE 1** Signifiers in field geomorphology

Type of signifier	Specific examples
Landscape	"detail of landscape," "different landscape types" (Q5/I9)
Form	"landforms in 3D" (Q3) "notches if you like, it's like big terraces" (I10/Q15) "it was full of polygons" (I6/Q35)
Sediments (deposits; exposures; sediment size/colour; sedimentary sections; stream bed sediments)	"exposures of river gravels," "little lenses of deposition" (I10/Q15) "these rocks seem smaller, and er, less angular" (I1/Q11) "looking at how the grains are arranged in a[n] area of bed the size of a dinner plate" (I7/Q17) "You think okay well that's a different colour to the rest of it, where has this stuff come from?" (I4/Q23) "I realised as I looked in the exposure that there were these huge blocks of rock" (I5/Q24)
Vegetation type	"salt tolerant plants" (I3/Q7)
Patterns (of river channel; in landscape)	"I guess I'll kinda look at it, figure out what the pattern of the river is, and then kind of go out from there" (I11/Q2) "other areas are a little bit simpler and then you start to notice, you start to recognise patterns in the field" (I8/Q22)
Change between visits (river channel/form; river stage; vegetation)	"so much had evolved and changed that it was still a bit difficult to place myself" (Q34)
Events (rare)	"I average a channel migration rate to thirty feet per year, what if you watch ten feet in five minutes, that's pretty cool you know?" (I7/Q17)

**TABLE 2** Signifieds in field geomorphology

Type of signified	Examples
Processes (transport processes; hydraulic processes; pedogenesis)	"their forming processes" (Q2/I11) "what process caused this to happen?" (Q29) "evidence of wind-blown or fluviually deposited material" (I10/Q15) "what's happening?" • "what is going on around me?" • "OK something has changed, and then what could be the cause of the change?" (I14/Q21)
Events (historic)	"past events" (Q3)
Sequences of events	"how the river got there, and ... how it incised" (I11/Q2) "thinking about how a landscape would have looked under the past, will look in the future, or would look now under different scenarios" (Q27/I12)
Interactions and relations (between landforms; between processes; cause and effect; controls)	"we very quickly got a good sense for the primary geomorphic controls in the reach" (Q16)

Moving to think about what is signified by these perceptual experiences (Table 2), again there are no great surprises: processes, events, sequences of events (landscape stories), and relations between processes or forms were all described. As I2/Q37 puts it:

[Y]ou're kind of trying to think "OK well that's ... draining that way, and that's why that looks like that, and that's why there's stuff growing over there, and this is what's happened here."

Again focusing on what geomorphologists described themselves doing, in moving from signifier to signified, there were references to describing, questioning, recording/note-taking, drawing, sketching, mapping, and photographing. But there were many references to discussing.

The embodied acts of walking, sitting, or standing to access the perceptual experience of seeing are thus combined with an explicitly cognitive step of drawing, questioning, discussing, etc., much of which is translating that perceptual experience into linguistic concepts. (Conventional mapping, although visual, ultimately maps objects/concepts that we can articulate linguistically. The key/legend translates between visual and linguistic communication forms.) None of this should be surprising: significant advances in geomorphological science made through the first half of the 20<sup>th</sup> century were accompanied by substantial growth in terminology.

W. M. Davis was said to have "coined more than a hundred and fifty technical terms, and his followers ... added more than a hundred more" (Beckinsale, 1976, p. 455). As geomorphologists learned to "see" more landforms, identify more evidence of processes/events/stories, a specialist vocabulary developed. Perceptual experience is also shaped by those linguistic concepts, shaping a sense of what counts as a worthwhile observation. We learn the sign in order to look for the signifiers—or rather (and in line with Wittgenstein's description of the "rules" of language-games), we learn the kinds of signs, the kinds of judgments that constitute geomorphological interpretation. So "seeing" geomorphologically is not a linear move from perceptive experience to linguistic articulation, but an interplay of the two. But there are particular bodily practices commonly used to enable that interplay:

Geomorphologists must be in possession of a camera and notebook at all times. It's essential to sit on a rock and take in the whole environment, how the landscape has been shaped here and now, and with the transgression of time. (Q18)

Field geomorphology is thus a "disciplined" corporeal-cognitive engagement with landscape/nature.

## SEEING IS SOCIAL

I think it does help if you are with somebody else. I think the most enjoyable times I've been with somebody else and it's been, that experience when you're kind of "Oh look at that, I wonder what's happening over there" and you are discussing it. (I2/Q37)

You'd sit around the fire and you'd talk about what you are seeing. ... As far as I'm concerned, that's part of being in the field, is to have that experience. (I6/Q35)

One, key thing that stands out is I got to go to this site with a very senior river engineer, who has intentionally invested in me, in a mentor type role, and so [it was] a chance to go to a site that neither of us were familiar with previously and learn it together. [That] was really neat. (I7/Q17)

Discussion has a central role in field interpretation. This was apparent in both the questionnaire and interviews, and it was often identified as one of the most positive aspects of fieldwork. As a means of sense-making, and developing and testing possible explanations, discussion with others is an important part of "reading" the landscape geomorphologically (Brierley et al., 2013). It is a way of establishing the meaning of signs, and/or synthesizing the meaning of multiple signs already understood (reading the landscape as text, perhaps).

There is a strong sense that this meaning-making is learned from others with more experience, and develops over time with accumulation of experience:

You can't possibly hope to be an expert on everything but, two things, it's just years and years and years of experience and, erm, interacting with colleagues. (I10/Q15)

Some participants indicated a deference to those with more experience (although two also noted that sometimes people with less experience can spot something new). One early career researcher expressed a perceived lack of experience, having not "done it with enough people to know, to hear their interpretations and compare it to mine, you know, in certain settings" (I11/Q2). Many participants were conscious of sharing their experience (sharing their meaning-making, their judgment), often through asking questions of others. This is particularly evident when talking about field teaching, but also in reflecting on their own learning:

[T]he supervisor that I had was very good at explaining things, I would say, and also like having me figure stuff out on my own too? You know being like "What do you see? Why is this here?" (I8/Q22)

However, this consciousness is not restricted to those with the most experience, or to those with formal teaching responsibilities. I1/Q11 was a Masters' student:

[I]t really makes you kind of think, about how you're explaining it to someone, and it helps your brain kind of rework through it and a lot of times I ended up bettering my understanding as I was trying to explain it to my partner.

This skill of “reading the landscape,” of meaning-making, is socially shaped, and entails exercising the shared judgment of the discipline (language-game) of geomorphology. That is, making sense of the physical landscape within the bounds of the kinds of judgments made in geomorphology. But being dependent on experience, including the social experiences of exercising (testing) this judgment and seeing others do so, suggests that field interpretation is dependent upon who is doing the interpreting, the kinds of landscapes they have experienced, and who they have experienced them with. In other words, positionality is important.

This clearly connects with an understanding of observation as theory-dependent, shaped by the prior assumptions we bring (Burt, 2003; Trudgill, 2003). However, it is not just about “theory” (ideas or concepts), but about experience of deploying the judgments of the discipline. These observations, the judgments made, often then shape site selection for quantitative fieldwork; decisions about where to measure, where to dig, where to monitor (Blue & Brierley, 2016):

So, the first day was all reconnaissance. We had ... a map of the locations ... and then we went out driving around trying to match them up and scouting out locations that would be like “Okay is this going to be a good spot, a representative spot that we could take some ... measurements on.” (I1/Q11)

[W]e spent a few hours then, basically on a walk-over of the site, deciding on where we were going to put different bits of equipment to measure streamflow, soil moisture, and take ... samples for soil carbon analysis. (I2/Q37)

Decisions based on interpretive observation thus shape other forms of evidence gathered, becoming sedimented into the knowledge record. For some consultancy work, interpretations and conclusions may be based entirely on observation:

[I]t's more of a, you kind of walk around in a group [of people and just look at stuff and come to a decision. (I4/Q23)

[C]ertainly with the kind of review work that I do, erm, you're pretty much forming the opinion in the field ... you know there's always a bit of a joke with that kind of work that you sort of write your report on the plane on the way back. (I4/Q23)

Isler et al. (2021) present an intersectional scientific methodology, which begins with “embodied observation.” They recognize the “technical expertise, situated knowledges, biases and lived experience that inform perception” (Isler et al., 2021, p. 20). We have now begun to unpack what that means for interpretive field geomorphology. The social nature of interpretive field geomorphology perhaps deserves further attention: are there particular observational and interpretive practices associated with particular social groups? A genealogical study of such practices may hold potential.

## “OBSERVATION” IS EMBODIED

There is a strong sense from participants that being in the field is “different.” Inevitably, geomorphologists self-selecting to participate in a study about field experiences will be those who value field experiences. Virtual field trips are never going to be quite as good in some sense:

[Y]ou know it deprives, I think it deprives us both in terms of research opportunities, and again understanding the landscape, it deprives our students from ... being able to understand these processes, and learning in context. (I12/Q27)

[T]his notion of the virtual fieldtrip ... I haven't really been convinced yet that it's any kind of substitute for ... good fieldwork, being outside really. I might not have seen very good examples, I haven't done much research into it but, I don't know whether that's a bit of bias on my account, I just kind of think it's never going to be as good as ... you know, being physically in the landscape. (I2/Q37)

[I]t's like, you can't really be an instructor on how to fly a Boeing 747 if you've never, actually, you know you can sit in a simulator but unless you've actually flown a Boeing, you—it's never quite the same. (I10/Q15)

Physical contact is part of this:

[B]eing out in the field and being able to see physical examples of the stuff I'm learning about or the stuff I am trying to research, it brings it to a different level than just reading about it and just getting taught a lecture about it. Just being able

to do it with your own two hands, I think, gives you a bit more than you ever could in just a straight classroom environment. (I1/Q11)

[S]o I got them into the field and that was always fun too because you know, the ... river was probably forty yards wide and less than knee deep. So I'd take my shoes off, trod out there and turn round, I'd got twenty-four people standing on the bank looking at me. I said "What are you doing there?" I said "You can't understand river dynamics from the bank, you have to be out here." (I6/Q35)

The immersion of fieldwork is clearly important. Paying closer attention, participants' descriptions of field sites are often (implicitly or explicitly) embodied:

These things are huge, in some places they are so big you can't, actually make out—the curvature of the Earth prevents you from seeing the horizon. (I10/Q15)

I think what I remember about the first sort of fieldwork I did in XXX was just the scale of the landscape ... it was just like this huge landscape. (I5/Q24)

[V]ery steep—very steep slopes, and so they've gulleyed so [there's] mass movement so it's kind of, you walk in over this very loose and steep ground. (I12/Q27)

A sense of scale, steepness of terrain, and the nature or stability of sediments is a bodily sense. Our understanding of the landscape is relative to our bodies first and foremost (Merleau-Ponty, 1962). Just one participant offered a more conscious articulation of embodied landscape interpretation:

[T]here's just no substitute, although high-resolution drone imagery is becoming almost a substitute, for erm, I guess the way to refer to it is the resolution that my eyes can pick up when I'm physically in a space. The ability to focus and focus very tightly, you know, at a very large range of scales as I move through a river. I can go from sketching out the macro-scale variability in channel hydraulics, you know on, a kilometre of river at once, to looking at how the grains are arranged in an area of bed the size of dinner plate. (I7/Q17).

But the significance of corporeal field experience seems to extend beyond this. At least for some participants, on some occasions, there was something almost inarticulable about the field experiences they were recounting:

For a moment I imagined that around the next bend I would drive right into the edge of the ice sheet. It was almost tangible. (Q6)

The landscape was so new and dynamic. Rockfall off of the crater rim was almost continuous. The dome included huge unstable boulders and narrow fractures that were scary deep. (Q5/I9)

And being in the field and seeing these ups and downs, like when walking perpendicularly to them—up and down and up and down, it was just so fascinating ... you can see beautiful images in textbooks, and you can Google beach ridges and find beautiful examples from all over the world, but actually being there yourself and understanding these swales and ridges, swales and ridges and up—it was really a learning experience for me. (I3/Q7)

Written quotes are inevitably limited in their ability to convey this; in interviews, this almost-inarticulable "something else" was evident not just in what was said, but also tone of voice and other non-verbal cues. It is an affective dimension to "being there." This is not simply an aesthetic experience, it is a geomorphological experience:

I like that kind of, er, sort of eureka for the students, when they suddenly see the picture. You know when it's almost like ... they suddenly open their eyes and they see things differently for the first time, and they realise the scale of the landscape and they realise the scale of the things they are looking at. (I5/Q24)

There is—or at least can be—then, an affective, relational dimension to geomorphological fieldwork. In some cases it seems the physical landscape has a "presence" that demands responding to, in much the way that Rautio (2013) describes children carrying stones

in their pockets as the stones demanding the children's attention. But in geomorphological fieldwork this is, or can be, a geomorphological responding-to:

[R]ivers are not uniform enough that I can hand somebody else—maybe I'm not experienced enough, some combination of these things—that I can hand somebody else a protocol that will pick up all of the important information. There's always something surprising, always something novel that in the end is very important. That fun story I was referring to earlier, right, that site exploration, there's something that I didn't expect to see that I will see when I actually get out in person. Like sometimes I'm not surprised but often I am. (I7/Q17)

Learning to see geomorphologically is not simply a matter of learning propositional knowledge, and learning to deploy propositional knowledge. These moments of transformation are arguably more about understanding. Wittgenstein (1953) demonstrates that the word “understanding” has a different grammar from “knowledge”; it functions differently in our lives, as a different concept. For Grimm (2021), the objects of understanding are more complex and interconnected than objects of propositional knowledge. Here we have seen that this understanding is arrived at relationally, through the corporeal experience of being there. And some respondents clearly indicated that this shaped their understanding of the geomorphology they were doing, even helping them develop their research questions:

Getting to see my sites in person. This is where I truly understand my geomorphology. (Q7/I3)

[T]o be on the ground and seeing what's happening, it really makes the data make more sense, you know, and provides that necessary context. (I12/Q27)

Being in the field and actually getting to see these river systems and the landscapes they interact with really helped me develop my research questions into a much bigger context—more so than I have been able to do from my desk! (Q8)

Our embodied being is a hinge (Wittgenstein, 1974) on which our sense of the world hangs. The landscape itself prompts an affective response, but the shift to understanding may indicate that (socially learned) propositional knowledge and judgment of the discipline connect with our embodied sense of the world, our sense of ourselves and our bodily capacities—which are subject to the same forces (gravity, friction) as geomorphological objects. Across the questionnaire and interviews, “understanding” was predominantly used in two contexts: understanding processes, and a vaguer sense of understanding the landscape. Non-specific though that may be, the participants above are clear that it contributes to their geomorphological thinking. This embodied, affective, inarticulable dimension of field experience can also become sedimented into the science. Such moments may be akin to Brierley et al.'s (2021) intuitive or instinctive capacity in geomorphological interpretation. But as a geomorphological response to landscape, it cannot be just intuitive or instinctive: seeing geomorphologically is learned. The materialities of landscape, our embodied and affective responding-to it, and learned disciplinary judgment come together.

## EPISTEMOLOGICAL IMPLICATIONS

Western science and “traditional epistemology” (Wild, 2008) prioritize propositional knowledge, rendering embodied and affective dimensions invisible (Santos, 2018; Wynter, 2003). Accounts of embodied and affective field experiences in geomorphology do exist (e.g., Burt, 2003; Tuan, 2009; Wohl, 2009), but such accounts are separate from the science, detached from knowledge production. As Rose (1993, p. 128) explains, “pleasure in the landscape is often seen as a threat to the scientific gaze.” Yet research participants clearly connected these affective and embodied experiences with development of understanding of geomorphology and of their field sites. Frodeman (1995) argues that geology (and geomorphology, by implication) synthesizes multiple forms of reasoning: the classical scientific deductive-nomological reasoning, and a hermeneutic, historical form of reasoning. We can now add that, for understanding geomorphology in the field, an embodied and affective, non-linguistic, dimension—perhaps a form of physical intuition—can also be present.

Consider the prominence of vision in science, geomorphology, and geomorphological/geographical education: detached observation “maintains an analytical distance” (Nairn, 1999, p. 273); technologies such as cameras, unmanned aerial vehicles, or satellites extend and enhance visual capacities, and record visual information; images in textbooks and on screens represent the landscape. Use of visual inscriptions (e.g., graphs, diagrams, pictures, maps) in journal publications has been found to be a marker of the “hard sciences” (Arsenault et al., 2006). This paper demonstrates that representation has epistemic, and so pedagogical, limits. Participants struggled to articulate why textbook images or virtual fieldtrips are “not the same” as being in the field, but their accounts of fieldwork—at least in some cases—offered glimpses of more-than-representational ways of knowing. Geomorphology is ultimately about understanding the processes that have shaped, and are shaping, the material landscape. As corporeal beings in the material world, our sense of the world is through our bodies, such that being in the field can

significantly enhance that understanding. This is not to claim that the affective geomorphological experiences discussed here will always happen. Rather, we can say that fieldwork offers conditions in which a shift to understanding can happen. This is an explicit acknowledgement that understanding is not solely cognitive. Brierley's (2020) account of asking students to "act me a river" would seem to align with this position.

The implications of this expanded account of interpretive field geomorphology—as a cognitive, social, embodied, and affective epistemic practice—are twofold.

First is contributing to Blue and Brierley's (2016) call for a more reflexive geomorphology. The cognitive dimension of interpretive field geomorphology is a learned skill, developed socially and experientially, suggesting that all such acts of interpretation are situated by the prior experience of the researcher(s). Further enquiry to investigate whether social networks of different observation/interpretive strategies exist could be beneficial to aiding recognition of researcher positionality, and hence aiding reflexivity. Where a more-than-representational understanding or intuition of landscapes/field sites is at work, there is scope for increased consciousness of the role this may play in research. The obvious challenges here are those of articulating the inarticulable, representing the more-than-representational. But awareness of the epistemological potential of embodied and affective field experience may heighten reflexive attention to how research projects are shaped, and what decisions may be influenced by such inarticulable understandings.

Second are implications for undergraduate and postgraduate education. "Getting your eye in" does not need to be mysterious. In articulating the epistemic processes at work, this paper provides clear rationale for structured, overt activities of observation and application of concepts, filtering those observations and discussing interpretations—i.e., testing out reasoning socially, and thereby developing skill in deploying the judgments of the discipline (the language-game). This adds to justifications for field-based pedagogies, based not only on outcomes or learning objectives, but on learning processes. Fieldwork appears to offer conditions in which a shift to understanding can happen, recognizing that understanding is not solely cognitive. For postgraduate researcher training, it is important to recognize that skill development in interpretive field geomorphology is not just reliant on "getting into the field" *per se*, important though this is. Skill development is also shaped by the range of geomorphological and social-geomorphological experiences (the range of landscapes interpreted, and who they are interpreted with). It is well recognized that structural inequalities in access to the discipline exist (Dowey et al., 2021; Mattheis et al., 2022; McAllister et al., 2022; Núñez et al., 2019), but differential social and economic capital (both individual and institutional) to access diverse field experiences may further reinforce such inequalities.

In paying close attention to geomorphologists' accounts of interpretive field geomorphology, this paper has articulated things that (many) field geomorphologists already know, albeit often tacitly. Its contribution lies specifically in articulating those things: it has expanded epistemic accounts of the discipline (Shotwell, 2017), in relation to one strand of evidence used in broader geomorphological interpretation (Brierley et al., 2021)—a strand that is often invisible in research publications. In doing so, the paper highlights an aspect of researcher positionality in geomorphology that may merit further attention, and thus contributes to the continuing development of critical physical geography. It also adds weight to the case for field-based pedagogies in geography, offering a rationale centred on epistemic processes rather than outcomes.

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