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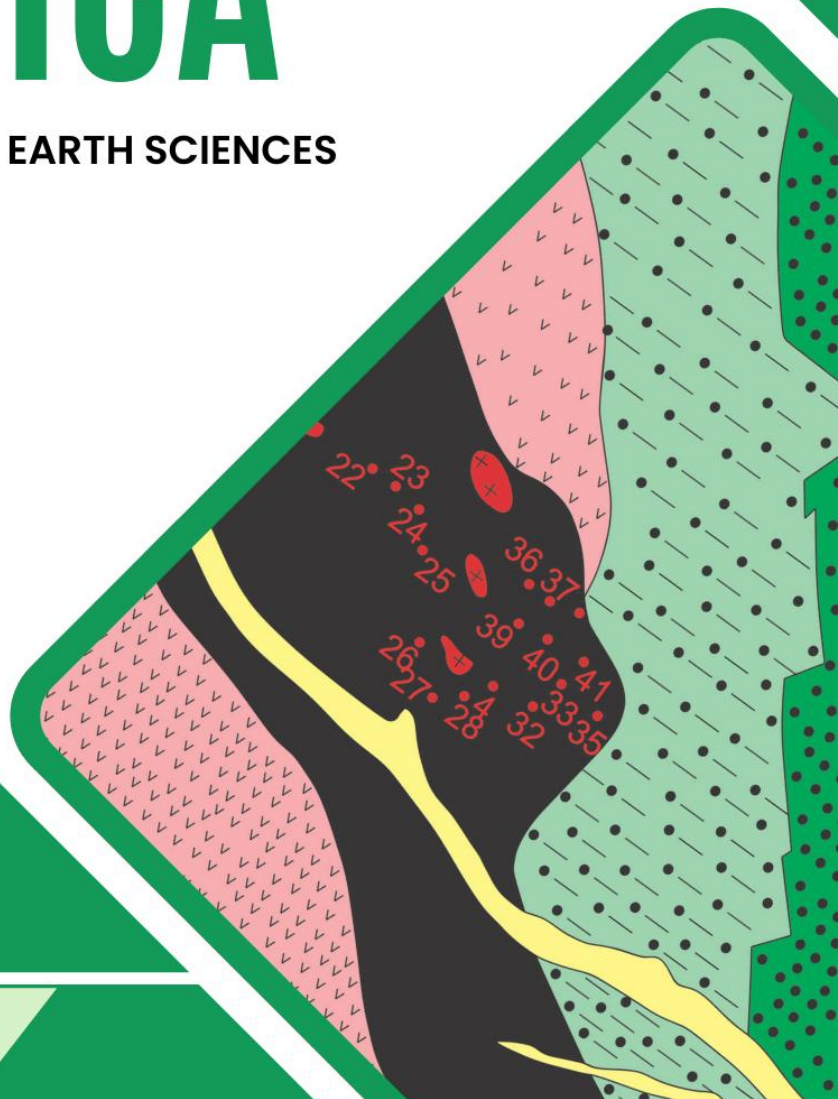
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A SYSTEMATIC APPROACH FOR STANDARDIZATION OF COLOURS AND CODES FOR VARIOUS GEOLOGICAL FORMATIONS OF PAKISTAN

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Abstract

Standardized colours and codes are essential for ensuring consistency in geological mapping. Currently, the Geological Survey of Pakistan lacks a unified theme for assigning colours and formation codes. This paper details the process and results of an initiative aimed at standardizing these codes and colours. We utilised the USGS colour scheme as a foundation to develop a tailored colour chart for the Geological Survey of Pakistan. It was very challenging to allocate a unique colour to each formation while ensuring that these colours are easily distinguishable across different maps. Our findings indicate that the adoption of these standardized codes and colours significantly improves the clarity of geological maps, enhances understanding among researchers, and fosters better collaboration among stakeholders. This standardized scheme provides a uniform reference system, thereby increasing the usability of geological maps and supporting more accurate and efficient geological analysis and communication.

Keywords: Pakistan, stratigraphy, colour and codes

Introduction

The desire to standardize geological norms is not new. It started as early as 1830s when different geological organizations started to address quarries regarding the uniformity of labels and colours (Rudwick, 1986; Corsi, 2007). Similarly, standardization; a process of creating heterogeneity based on agreed set of rules; is also not a new phenomenon (Clarke and Fujimira, 1992; Alder, 2002, Slaton, 2003). Based on these finding different geological surveys and organizations have already created their colour schemes (USGS, 2006; Ogg et. al., 2021). In Pakistan, Geological Survey of Pakistan has been designated to disseminate all the geological data in the form of maps and reports (Mineral Policy, 1995). But unfortunately, there is no uniformity in terms of labels and colours. For example, symbol for Kirther Formation

has been designated as Pkr on 35-N/7 (Khazada et. al., 2001) whereas Tk on 34-O/6 (Ahmed et, al., 2001). Similarly Dada Conglomerate on 34-O/6 (Ahmed et, al., 2001) as Qdc and on 35-N/7 (Khazada et. al., 2001), it is ND. Likewise, different authors use different colours for the same formation. Example includes Sember Formation which is light blue on 35-J/11 (Faridudin et. al., 1988) and dark green on 35-J/12 (Sarwar et. al., 1988). This creates a confusion that needs to address on priority. This paper designates the new standardized colour codes (SCC) and standardized formation code (SFC) for the lithological units exposed in Pakistan, for digitally published geological maps. Initially, these colour codes were proposed for the Accelerated Geological Mapping project (2023-25), but its use was then extended to other similar programs like KP

Mapping Project (2022-24). While the BGS and USGS standards give extensive systems for geological mapping, they are inadequate in many ways to address the geology of Pakistan perfectly. This is because most of the classifications upon which the standards are built do not apply to the formations that exist in Pakistan. Also, the integration of this standard with commonly used digital mapping in Pakistan presents challenges emanating from discrepancies in colour schemes, classification criteria, and data structuring. Therefore, a localized system was necessary to develop something that would not only best represent the geological diversity of Pakistan but also have regional mapping practicability and improved utility for research and practical applications.

The purpose of this standardization exercise was to fill the gap between outdated geological maps produced by draftsmen and newly produced maps on ArcGIS software.

The idea was initiated in the Management Advisory Committee (MAC) meeting and the author was entrusted to complete the task. The first draft of SCC and SFC was circulated among the directors for their valuable suggestions. After Incorporation of all suggestions final draft was submitted to Honorable Director General, who then accepted it.

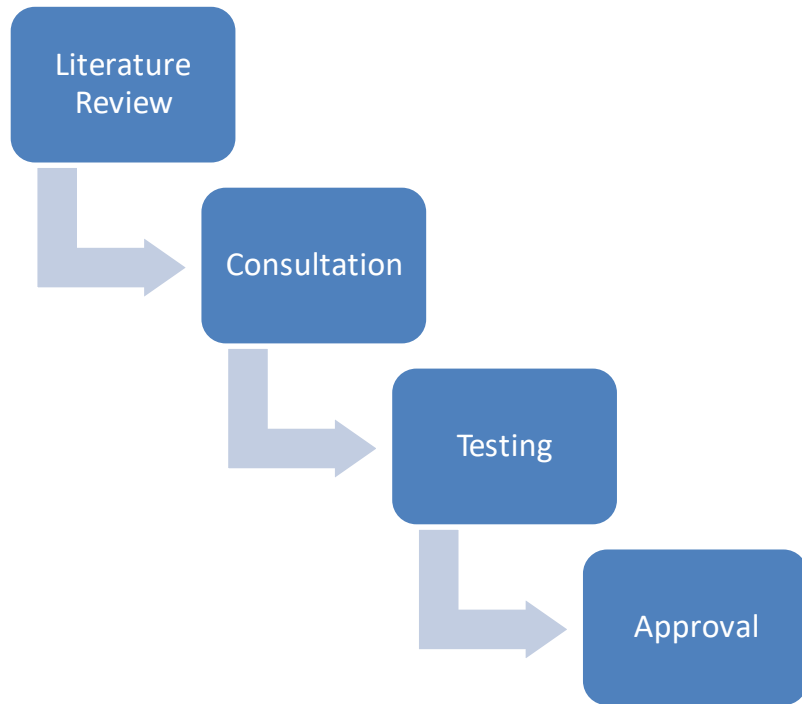
Methodology

The methodology opted for the SCC and SFC for various rock units is based on following steps and is shown in the fig. 1:






















- A thorough review of existing standards on geological colour-codes was carried out, especially United States Geological Survey (FGDC, 2006) for the colours used in different ages.
- After review and consultation made with the senior colleagues, an initial colour scheme was developed. Every formation was dispensed a unique code and colour in R, G, B (Red, blue and green) and C, M, Y, K (cyan, magenta, yellow and black) codes, while taking in consideration various factors including distinguishability and visibility. RGB colours are suitable for the raster images that are only in digital format, whereas CMYK is appropriate for the maps that will be printed. So both of these colours schemes are given. Correlation charts of GSP (Vol. 12) were also considered for assigning the same colour to correlated formations of different basins.
- This scheme was then tested on different geological maps to ensure effectiveness and clarity. It was also circulated to all regional offices for their valuable suggestions.
- After all discussions, review and testing, standardized colour and codes were documented, this was approved by the Director General, Geological Survey of Pakistan.




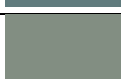

















Results



















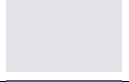
The standardized colour scheme comprises of a complete palette of colours given to various rock units. The table given below represents the standardized codes and colour for majority of rock units mentioned in Memoir volume 22 (Shah, 2009).



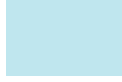







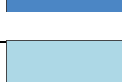

































Sr. No.	Age	Formation Name	Codes	Colour Selector		Pictorial Representation
				R, G, B	C, M, Y, K	
1.	Precambrian	Nagar Parkar igneous complex	pCnp	222, 204, 204	12, 19, 14, 0	
2.		Hachi group	pCha	222, 204, 204	12, 19, 14, 0	
3.		Kirana group	pCk	204, 179, 179	20, 30, 24, 0	
4.		Taguwali formation	pCta	179, 153, 153	32, 41, 35, 0	
5.		Asianwala quartzite	pCas	204, 128, 179	18, 62, 1, 0	
6.		Sharaban group	pCs	222, 179, 204	11, 33, 4, 0	
7.		Hadda quartzite	pChq	222, 204, 222	11, 20, 2, 0	
8.		Sharaban conglomerate	pCsc	222, 235, 179	14, 0, 38, 0	
9.		Salt Range Formation	pCsr	222, 204, 204	12, 19, 14, 0	



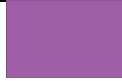


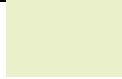


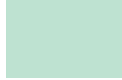

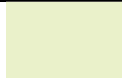





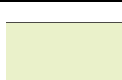



10.		Manki Formation	pCm	222, 204, 204	12, 19, 14, 0	
11.		Shahkot Formation	pCsh	204, 179, 179	20, 30, 24, 0	
12.		Uch Khattak Formation	pCuk	179, 153, 153	32, 41, 35, 0	
13.		Shekhai Formation	pCsa	204, 128, 179	18, 62, 1, 0	
14.		Dakhner Formation	pCd	222, 179, 204	11, 33, 4, 0	
15.		Hazara Formation	pCh	222, 204, 204	12, 19, 14, 0	
16.		Salkhala Formation	pCsk	204, 204, 153	22, 13, 49, 0	
17.		Tanawal Formation	pCt	179, 179, 102	34, 21, 78, 0	
18.		Sharda group	pCsd	179, 153, 77	31, 36, 89, 4	
19.		Sharda formation	pCsf	204, 179, 128	22, 27, 58, 0	
20.		Naran garnetiferous calc -pelites	pCng	222, 204, 179	13, 18, 30, 0	
21.		Gamot formation	pCga	204, 135, 153	20, 57, 25, 0	
22.		Manglaur group	pCma	179, 204, 128	34, 5, 66, 0	
23.		Pacha formation	pCp	153, 179, 77	47, 15, 97, 0	
24.		Swat granite gneiss	pCsg	179, 179, 179	31, 25, 25, 0	
25.		Alpurai group	pCal	204, 204, 204	20, 16, 16, 0	
26.		Salampur formation	pCsl	222, 235, 222	13, 2, 14, 0	
27.		Tilgram formation	pCti	180, 204, 204	31, 11, 18, 0	
28.		Dargai formation	pCda	128, 179, 179	53, 16, 30, 0	
29.		Saidu schist	pCsi	204, 222, 222	20, 5, 11, 0	
30.		Besham complex	pCbc	179, 153, 102	31, 37, 73, 4	






















31.		Besham group	pCbg	125, 125, 200	58, 55, 0, 0	
32.		Kishar formation	pCki	58, 96, 110	87, 55, 45, 24	
33.		Karora group	pCka	96, 123, 125	69, 42, 47, 12	
34.		Gandaf formation	pCg	130, 142, 130	53, 36, 50, 6	
35.		Kaghan group	pCkg	170, 174, 142	36, 24, 51, 0	
36.		Rajwal formation	pCr	102, 98, 78	56, 50, 73, 33	
37.		Julgran formation	pCj	193, 190, 170	26, 20, 35, 0	
38.		Mahandry formation	pCmh	159, 154, 122	40, 33, 59, 4	
39.		Jobra formation	pCjb	109, 93, 70	49, 55, 78, 36	
40.	Cambrian	Khewra Sandstone	Cjkh	255, 128, 153	0, 65, 20, 0	
41.		Kussak Formation	Cjkk	255, 204, 222	0, 25, 0, 0	
42.		Jutana Formation	Cjj	255, 153, 179	0, 53, 9, 0	
43.		Baghanwala Formation	Cjb	235, 128, 153	3, 65, 20, 0	
44.		Khisor Formation	Ck	255, 179, 204	0, 39, 2, 0	
45.		Darwaza Formation	Cd	255, 128, 153	0, 65, 20, 0	
46.		Abbottabad Formation	Ca	255, 204, 222	0, 25, 0, 0	
47.		Hazira Formation	Ch	255, 153, 179	0, 53, 9, 0	
48.		Ambar formation	Cam	235, 128, 153	3, 65, 20, 0	
49.		Girarai formation	Cg	255, 168, 227	3, 42, 0, 0	
50.		Tursak formation	Ct	255, 179, 204	0, 39, 2, 0	
51.		Chikar quartzite	Cc	255, 128, 153	0, 65, 20, 0	






















52.		Aghost formation	Cag	255, 204, 222	0, 25, 0, 0	
53.	Ordovician-Silurian	Hisartang Formation	Oh	198, 188, 185	23, 24, 23, 0	
54.		Landikotal formation	Ol	224, 212, 209	11, 15, 13, 0	
55.		Misri Banda quartzite	Om	229, 209, 204	9, 17, 15, 0	
56.		Panjpир formation	Sp	204, 184, 179	20, 27, 25, 0	
57.		Baroghil group	Ob	183, 155, 148	30, 40, 39, 0	
58.		Yarkhun formation	Oy	204, 184, 179	20, 27, 25, 0	
59.		Vidiakot formation	Ov	210, 180, 173	18, 30, 27, 0	
60.		Devonian	Inzari limestone	Di	120, 118, 148	61, 56, 26, 4
61.	Ali Masjid formation		Da	204, 204, 255	18, 18, 0, 0	
62.	Shagai formation		Ds	153, 179, 235	39, 24, 0, 0	
63.	Nowshera formation		Dn	179, 179, 255	29, 28, 0, 0	
64.	Pir Sabak formation		Dp	164, 162, 182	38, 34, 18, 0	
65.	Charun quartzite		Dc	120, 118, 148	61, 56, 26, 4	
66.	Shogram formation		Dsh	204, 204, 255	18, 18, 0, 0	
67.	Lun shale		DI	153, 179, 235	39, 24, 0, 0	
68.	Sarikol shale		Dsa	179, 179, 255	29, 28, 0, 0	
69.	Owir formation		Do	164, 162, 182	38, 34, 18, 0	
70.	Wakhan formation		Dw	228, 228, 234	9, 7, 4, 0	
71.	Chilmarabad formation		Dch	93, 91, 116,	72, 68, 36, 18	
72.	Carboniferous-Permian		Nilawahan Group	Pn	230, 255, 255	7, 0, 1, 0



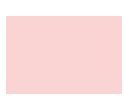


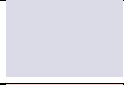









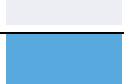




73.	Tobra Formation	Pnt	128, 255, 235	40, 0, 19, 0	
74.	Dandot Formation	Pnd	102, 255, 255	44, 0, 11, 0	
75.	Warchha Sandstone	Pnw	179, 255, 255	24, 0, 5, 0	
76.	Sardhai Formation	Pns	128, 204, 235	47, 3, 3, 0	
77.	Zaluch Group	Pz	102, 255, 204	47, 0, 36, 0	
78.	Amb Formation	Pza	128, 179, 222	50, 18, 0, 0	
79.	Wargal Limestone	Pzw	70, 130, 180	79, 45, 10, 0	
80.	Chhidru Formation	Pzc	100, 149, 237	62, 39, 0, 0	
81.	Jafar Kandao formation	Pj	0, 191, 255	66, 6, 0, 0	
82.	Panjral formation & agglomerate slate	PCpa	30, 144, 255	75, 42, 0, 0	
83.	Darkot group	Pd	173, 216, 230	31, 3, 7, 0	
84.	Rawat formation	Pr	135, 206, 235	45, 3, 4, 0	
85.	White marble	Pw	0, 0, 205	100, 89, 0, 1	
86.	Gum formation	Pg	65, 105, 225	78, 64, 0, 0	
87.	Barum formation	Pb	138, 43, 226	65, 84, 0, 0	
88.	Basal shale	Pbs	75, 0, 130	85, 100, 8, 23	
89.	Chalt schist	CPc	72, 61, 139	95, 100, 9, 2	
90.	Baltit group	CPb	106, 90, 205	72, 74, 0, 0	
91.	Pasu slate	CPp	147, 112, 219	55, 65, 0, 0	
92.	Chitral slate	Pc	148, 0, 211	62, 90, 0, 0	
93.	Krinj limestone	Pk	186, 85, 211	42, 78, 0, 0	

















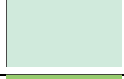




94.		Dobargar formation	Pdr	128, 0, 128	63, 100, 17, 9	
95.		Nialthi formation	Pni	139, 0, 139	60, 100, 11, 3	
96.	Carboniferous of Karambar and adjacent area	Margach formation	Cm	230, 255, 255	7, 0, 1, 0	
97.		Ribat formation	Cr	128, 255, 235	40, 0, 19, 0	
98.		Lupsuk formation	Cl	102, 255, 255	44, 0, 11, 0	
99.		Gircha formation	Cga	179, 255, 255	24, 0, 5, 0	
100.		Kilik formation	Ckk	128, 204, 235	47, 3, 3, 0	
101.		Guhjal formation	Cgu	102, 255, 204	47, 0, 36, 0	
102.		Chapursan group	Ccn	128, 179, 222	50, 18, 0, 0	
103.		Lashkargaz formation	Cla	70, 130, 180	79, 45, 10, 0	
104.		Lupghar formation	Clu	100, 149, 237	62, 39, 0, 0	
105.		Panjshah formation	Cp	0, 191, 255	66, 6, 0, 0	
106.		Gharil formation	Cgh	30, 144, 255	75, 42, 0, 0	
107.		Ailak formation	Cak	173, 216, 230	31, 33, 7, 0	
108.		Kundil formation	Cku	135, 206, 235	45, 3, 4, 0	
109.		Wirokhun formation	Cw	0, 0, 205	100, 89, 0, 1	
110.	Misghar slate	Cmi	65, 105, 225	80, 64, 0, 0		
111.	Staghar formation	Cs	138, 43, 226	65, 84, 0, 0		
112.	Shaksgam formation	Csf	75, 0, 130	85, 100, 8, 23		
113.	Shaksgam Valley sandstone	Css	72, 61, 139	95, 100, 9, 2		
114.	Singhie shale	Csi	106, 90, 205	72, 74, 0, 0		





















115.		Zait formation	Cz	147, 112, 219	55, 65, 0, 0	
116.		Ganchen formation	Cgn	148, 0, 211	62, 90, 0, 0	
117.		Dumordo group	Cdo	186, 85, 211	42, 78, 0, 0	
118.		Skamri limestone	Csk	128, 0, 128	63, 100, 17, 9	
119.		Dumultar formation	Cdu	139, 0, 139	60, 100, 11, 3	
120.	Triassic	Musakhel Group	Tmu	235, 255, 204	8, 0, 26, 0	
121.		Mianwali Formation	Tmm	153, 255, 204	35, 0, 33, 0	
122.		Tredian Formation	Tmt	128, 235, 179	45, 0, 44, 0	
123.		Kingriali Formation	Tmki	179, 255, 222	26, 0, 22, 0	
124.		Chak Jabbi Limestone	Tci	102, 255, 204	47, 0, 36, 0	
125.		Khanozai Group	Tkh	235, 255, 204	8, 0, 26, 0	
126.		Gwal Formation	Tgw	153, 255, 204	35, 0, 33, 0	
127.		Wulgai Formation	Tw	128, 235, 179	45, 0, 44, 0	
128.		Spalga formation	Tsp	128, 235, 179	45, 0, 44, 0	
129.		Triassic paleogeography	Karapa greenschist	Tkg	179, 255, 222	26, 0, 22, 0
130.	Kashala formation		Tks	102, 255, 204	47, 0, 36, 0	
131.	Nikanai formation		Tnk	13, 152, 186	84, 25, 19, 0	
132.	Banna and landai formations		Tbl	235, 255, 204	8, 0, 26, 0	
133.	Landai formation		Tla	153, 255, 204	35, 0, 33, 0	
134.	Borom formation		Tbo	179, 255, 222	26, 0, 22, 0	
135.	Chikchi-Ri shale		Tcr	102, 255, 204	47, 0, 36, 0	

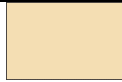




















136.		Urdok conglomerate	Tuc	13, 152, 186	84, 25, 19, 0	
137.	Jurassic	Surghar Group	Js	152, 251, 152	38, 0, 61, 0	
138.		Datta Formation	Jsd	154, 205, 50	46, 0, 100, 0	
139.		Shinawari Formation	Jssh	124, 252, 0	51, 0, 100, 0	
140.		Samana Suk Formation	Jss	173, 255, 47	36, 0, 100, 0	
141.		Ferozabad Group	Jf	152, 251, 152	38, 0, 61, 0	
142.		Kharrari Formation	Jfk	154, 205, 50	46, 0, 100, 0	
143.		Malikhore Formation	Jfm	124, 252, 0	51, 0, 100, 0	
144.		Anjira Formation	Jfa	173, 255, 47	36, 0, 100, 0	
145.		Shirinab Formation	Jsb	0, 100, 0	86, 37, 100, 35	
146.		Alozai group	Ja	34, 139, 34	88,21, 100, 9	
147.		Spingwar Formation	Jas	0, 255, 0	65, 0, 100, 0	
148.		Loralai Formation	Jal	0, 250, 154	60, 0, 65, 0	
149.		Takatu Formation	Jt	0, 255, 127	61, 0, 82, 0	
150.		Mazar Drik Member	Jmd	50, 205, 50	73, 0, 100, 0	
151.		Sarobi formation	Jsi	0, 255, 0	65, 0, 100, 0	
152.		Isha formation	Ji	173, 255, 47	36, 0, 100, 0	
153.	Liassic paleogeography	Aghil limestone	LJa	154, 205, 50	46, 0, 100, 0	
154.		Yashkuk formation	LJy	152, 251, 152	38, 0, 61, 0	
155.		Reshit formation	LJr	124, 252, 0	51, 0, 100, 0	
156.		Bdongo-La formation	LJb	0, 100, 0	86, 37, 100, 35	


















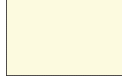


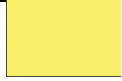
157.	Cretaceous	Chichali Formation	Kc	95, 108, 60	64, 41, 100, 29	
158.		Lumshiwai Formation	Kl	77, 102, 62	73, 40, 98, 33	
159.		Kawagarh Formation	Kk	83, 115, 76	72, 36, 87, 24	
160.		Mona Jhal Group	Km	88, 113, 63	69, 37, 100, 26	
161.		Sembar Formation	Kms	95, 108, 60	64, 41, 100, 29	
162.		Goru Formation	Kmg	77, 102, 62	73, 40, 98, 33	
163.		Parh Limestone	Kmp	83, 115, 76	72, 36, 87, 24	
164.		Moghal Kot Formation	Kmk	109, 114, 68	57, 41, 93, 25	
165.		Fort Munro Formation	Kmf	87, 98, 56	65, 44, 100, 36	
166.		Pab Sandstone	Kmpb	95, 96, 51	60, 47, 100, 36	
167.		Moro Formation	Kmm	96, 98, 65	59, 47, 88, 35	
168.	Cretaceous paleogeography	Sinjrani Volcanic group	Ksv	95, 108, 60	64, 41, 100, 29	
169.		Humai formation	Kh	77, 102, 62	73, 40, 98, 33	
170.		Bela Volcanic group	Kb	109, 114, 68	57, 41, 93, 25	
171.		Chashmai Kharsai formation	Kck	83, 115, 76	72, 36, 87, 24	
172.		Marsikhel formation	Kml	88, 113, 63	69, 37, 100, 26	
173.		Zerghar formation	Kz	87, 98, 56	65, 44, 100, 36	
174.	Cretaceous of Kohistan Island Arc	Jijal complex	Kj	106, 0, 106	66, 100, 22, 29	
175.		Tora Tigga complex	Ktt	106, 0, 106	66, 100, 22, 29	
176.		Sapat complex	Ks	106, 0, 106	66, 100, 22, 29	
177.		Kohistan batholith	TKkb	252, 110, 124	0, 75, 38, 0	






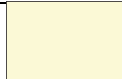






178.	Jaglot group	Kjl	255, 87, 255	22, 71, 0, 0	
179.	Gilgit formation	Kg	144, 99, 255	62, 69, 0, 0	
180.	Gashu-Confluence volcanics	Kgc	249, 211, 211	0, 20, 9, 0	
181.	Thelechi formation	Kt	230, 205, 255	10, 20, 0, 0	
182.	Kalam group	Kkl	159, 255, 159	36, 0, 57, 0	
183.	Chalt schist	Kcs	219, 219, 231	13, 11, 3, 0	
184.	Chilas complex	Kcc	255, 214, 209	0, 20, 11, 0	
185.	Yasin group	Ky	96, 204, 191	59, 0, 33, 0	
186.	Shamran volcanic group	Tsv	177, 72, 1	21, 85, 100, 16	
187.	Gawuch formation	Kgw	180, 207, 228	29, 10, 4, 0	
188.	Purit formation	Kp	172, 228, 200	33, 0, 28, 0	
189.	Drosh formation	Kd	201, 82, 1	15, 83, 100, 7	
190.	Dir group	Tdi	244, 139, 0	2, 56, 100, 0	
191.	Utror volcanic group	Tu	235, 96, 1	3, 79, 100, 0	
192.	Baraul Banda slate	Tbb	255, 183, 222	0, 36, 0, 0	
193.	Koghuzi greenschist	Kkg	237, 237, 243	5, 4, 1, 0	
194.	Gahiret limestone	Kgt	67, 175, 249	64, 20, 0, 0	
195.	Greenstone complex	Kgs	0, 128, 0	93, 24, 100, 15	
196.	Turmik formation	Ktu	150, 150, 150	45, 37, 38, 2	
197.	Askore amphibolite	Ka	123, 0, 156	69, 100, 2, 1	

198.		Tsordas gneiss	Kts	236, 214, 254	7, 16, 0, 0	
199.		Bauma Harel schist	Kbh	162, 162, 192	39, 35, 11, 0	
200.		Askole amphibolite unit	Kaa	159, 0, 202	56, 92, 0, 0	
201.		Hashupa limestone	Khh	86, 224, 252	52, 0, 4, 0	
202.		Ganto-La group	Kgl	67, 175, 249	64, 20, 0, 0	
203.		Skoro Lumba slate	Ksl	125, 255, 125	46, 0, 78, 0	
204.		Nang Brok quartzite	Knb	167, 167, 255	35, 35, 0, 0	
205.		Panah ultramafic unit	Kpu	232, 0, 55	2, 100, 95, 0	
206.		Daltumbore (micaschist formation)	Pda	177, 177, 177	33, 26, 27, 0	
207.		Dassu gneiss	Kdg	236, 214, 254	7, 16, 0, 0	
208.		Skoyo gneiss	Ksg	100, 2, 11	43, 91, 81, 65	
209.		Katzarah formation	Kkt	125, 255, 125	46, 0, 78, 0	
210.		Burjila formation	Kbj	201, 255, 201	20, 0, 30, 0	
211.		Reshun conglomerate	Kr	183, 217, 204	29, 3, 22, 0	
212.		Tupop formation	Ktp	205, 255, 217	18, 0, 22, 0	
213.		Darband formation	Kdb	207, 239, 223	18, 0, 16, 0	
214.		Sarpo Lago slate	Psl	125, 255, 125	46, 0, 78, 0	
215.		Savoia formation	Ksa	182, 182, 206	29, 25, 7, 0	
216.		Khalkhal formation	Kkk	172, 127, 80	29, 51, 82, 10	
217.		Hushe complex	Jh	163, 1, 9	22, 100, 100, 25	
218.		K2 gneiss	Kk2	236, 214, 254	7, 16, 0, 0	

219.		Falchan Kangri gneiss	Kfk	100, 2, 11	43, 91, 81,65	
220.	Paleocene	Makarwal Group	Tm	255, 204, 153	0, 22, 43, 0	
221.		Hangu Formation	Tmh	255, 235, 175	0, 5, 38, 0	
222.		Lockhart Limestone	Tml	255, 211, 127	0, 18, 61, 0	
223.		Patala Formation	Tmp	255, 179, 102	0, 36, 71, 0	
224.		Ranikot Group	Tr	255, 209, 145	0, 20, 49, 0	
225.		Khaskheli Basalt	Tkk	235, 179, 102	7, 32, 73, 0	
226.		Khadro Formation	Trko	205, 133, 63	18, 55, 97, 3	
227.		Bara Formation	Trb	245, 222, 179	4, 11, 33, 0	
228.		Lakhra Formation	Trl	210, 180, 140,	18, 29, 50, 0	
229.		Rakhi Guj Formation	Trj	139, 69, 19	31, 78, 100, 33	
230.		Dungan Formation	Td	255, 211, 127	0, 18, 61, 0	
231.		Paleocene paleogeography	Rakhshani formation	Trs	255, 170, 0	0, 39, 100, 0
232.	Ispikan conglomerate		Ti	235, 204, 153	7, 19, 45, 0	
233.	Eocene	Chharat Group	Tc	210, 180, 140	18, 29, 50, 0	
234.		Panoba Shale	Tcp	255, 170, 0	0, 39, 100, 0	
235.		Gurguri sandstone	Tgi	235, 153, 0	7, 46, 100, 0	
236.		Shekhan Formation	Tcs	218, 165, 32	16, 36, 100, 0	
237.		Bahadur Khel Salt	Tcb	230, 152, 0	9, 45, 100, 0	
238.		Jatta Gypsum	Tcj	168, 112, 0	30, 57, 100, 15	
239.		Margala Hill Limestone	Tcm	245, 202, 122	4, 21, 64, 0	

240.		Chorgali Formation	Tcc	245, 222, 179	4, 11, 33, 0	
241.		Kuldana Formation	Tcku	205, 170, 102	21, 32, 74, 0	
242.		Kohat Formation	Tck	137, 112, 68	41, 51, 89, 22	
243.		Nammal Formation	Tcn	137, 90, 68	35, 67, 80, 28	
244.		Sakesar Limestone	Tesk	137, 112, 68	41, 51, 89, 22	
245.		Ghazij Group	Tg	205, 170, 102	21, 32, 74, 0	
246.		Shaheed Ghat Formation	Tgs	218, 165, 32	16, 36, 100, 0	
247.		Drug Formation	Tgd	255, 235, 179	0, 5, 36, 0	
248.		Toi Formation	Tgt	137, 112, 68	41, 51, 89, 22	
249.		Baska Formation	Tgb	245, 202, 122	4, 21, 64, 0	
250.		Kirthar Formation	Tk	168, 112, 0	30, 57, 100, 15	
251.		Laki Formation	Tl	210, 105, 30	14, 72, 100, 3	
252.		Habib Rahi Formation	Th	230, 152, 0	9, 45, 100, 0	
253.		Domanda Formation	Tdd	255, 170, 0	0, 39, 100, 0	
254.		Pirkoh Formation	Tp	255, 179, 102	0, 36, 71, 0	
255.		Drazinda Formation	Tdz	255, 235, 175	0, 5, 38, 0	
256.		Saindak formation	Tsa	255, 179, 102	0, 36, 71, 0	
257.		Kharan formation	Tka	205, 170, 102	21, 32, 74, 0	
258.		Nisai formation	Tni	137, 90, 68	35, 67, 80, 28	
259.	Oligocene	Momani Group	Tmg	255, 204, 153	0, 22, 43, 0	
260.		Nari Formation	Tna	235, 179, 102	7, 32, 73, 0	

261.		Chitarwatta Formation	Tcw	235, 153, 0	7, 46, 100, 0		
262.		Bugti Formation	Tb	139, 69, 19	31, 78, 100, 33		
263.		Amalaf formation	Ta	255, 204, 102	0, 21, 73, 0		
264.		Makran group	Tmk	255, 204, 153	0, 22, 43, 0		
265.		Khojak formation	Tkj	230, 152, 0	9, 45, 100, 0		
266.	Miocene- Pliocene	Rawalpindi Group	Trg	255, 209, 145	0, 20, 49, 0		
267.		Murree Formation	Trm	235, 153, 0	0, 35, 100, 8		
268.		Kamlial Formation	Trk	235, 179, 102	7, 32, 73, 0		
269.		Chinji Formation	Tch	235, 204, 153	7, 19, 45, 0		
270.		Nagri Formation	Tn	255, 204, 102	0, 21, 73, 0		
271.		Dhok Pathan Formation	Tdp	255, 235, 179	0, 5, 36, 0		
272.		Soan Formation	Ts	255, 255, 222	1, 0, 15, 0		
273.		Samwal formation	Tsm	245, 202, 122	4, 21, 64, 0		
274.		Kakra formation	Tkr	255, 235, 175	0, 5, 38, 0		
275.		Mirpur formation	Tmi	139, 69, 19	31, 78, 100, 33		
276.		Gaj formation	Tgj	255, 255, 222	1, 0, 15, 0		
277.		Hinglaj formation	Thg	255, 211, 127	0, 18, 61, 0		
278.		Pleistocene	Lei Conglomerate	Ptl	255, 255, 222	1, 0, 15, 0	
279.			Gwadar formation	Ptg	255, 255, 222	1, 0, 15, 0	
280.	Jiwani formation		Ptj	255, 235, 102	2, 3, 76, 0		
281.	Haro conglomerate		Pth	255, 255, 102	4, 0, 74, 0		

282.		Bostan formation	Ptb	255, 255, 179	2, 0, 37, 0	
283.	Quaternary	Stream Bed deposits	Qsb	Code 607, Sand in ArcGIS		
284.		Alluvial Deposits	Qa	255, 255, 137	3, 0, 58, 0	
285.		Eolian deposits	Qe	224, 197, 158	13, 22, 42, 0	
286.		Terrace Gravel Deposits	Qt	236, 180, 0	8, 30, 100, 0	
287.		Fan Deposits	Qf	255, 255, 213	1, 0, 20, 0	
288.		Coastal sand deposits	Qcs	255, 203, 35	0, 20, 100, 0	
289.		Beach sand deposits	Qb	224, 210, 180	12, 14, 31, 0	
290.		Cultivated deposits	Qcu	253, 244, 63	5, 0, 87, 0	
291.		Moraine	Qm	255, 238, 191	0, 5, 29, 0	
292.		Scree	Qs	225, 227, 195	12, 5, 27, 0	
293.		River/Lake		115, 223, 255	46, 0, 1, 0	

Each and every colour was selected very carefully so that it was distinct from others and easily identifiable on geological maps. Same colour was assigned to formations that are either correlated or impossible for them to co-exist like Sember Formation and Chichali Formation are corelated and Nagar Parkar igneous complex and Salt Range Formation can't co-exist. These colours are compatible with software like ArcGIS, QGIS and CorelDraw. Moreover, the codes will provide a reference for geologists, helping effectual interpretation of geological data.

Discussion

It's a very challenging task to standardize the formation labels and colour codes for

the lithological units in mapping. Primarily, USGS colour scheme and the standards for age-based colour of FGDC have been selected for coding. Regardless of systematic approach, numerous issues arose which required additional refinement. A major challenge was to address the already existing discrepancies and inconsistencies in formation labels and colour codes. For example, Kirther Formation was represented by both Tkr and Pkr. Moreover, Sember Formation was given colours green and blue on different maps. These inconsistencies generated confusion and might lead to misinterpretations in mosaics. To address these problems, we established a uniform set of colours and codes. We assigned

different shades within a colour category and confirmed that formations are evidently distinct on maps. To reduce the number of shades within the same category, we used correlation charts. This helped in maintaining clarity and reduced complexities. The said issue was predominantly a challenge for age-like Tertiary having a wide range of formations. The given scheme reduced the aforementioned ambiguities.

After the introduction of this new standardized scheme, we faced a little resistance from some quarters, as they were more comfortable in using the existing practices. The major concern was colour differentiation. To overcome this conflict, we run trials to demonstrate the efficiency and clarity of this new scheme. We produced and printed maps to validate the successful implementation of this scheme. To ensure the broad acceptance of this scheme, we showed flexibility on low critical points and a balanced approach on core elements.

Conclusion

The newly introduced standardized colour scheme and formation label has proven the necessary advancement in the improving clarity and uniformity of geological representations. This standardized scheme has considerably reduced the ambiguities and inconsistencies of the previously available maps. This systematic approach ensures that the lithological units are easily differentiable on geological maps, thus improve the clarity and usability of maps. The researchers will get the data in a consistent format, thus reducing the time and resources, required in conversions. This will also increase the efficiency of the researchers. The given scheme aligns with international standards and successfully

implemented in two different projects of the Geological Survey of Pakistan. This scheme will aid as a foundation for forthcoming iterations of similar activities.

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Appendix 1 from Geologic Time Scale
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