AEROPHOTO INTERPRETATION OF GEOLOGICAL STRUCTURES ON THE SURFACE ABOVE THE PREDJAMA CAVE

AEROFOTO INTERPRETACIJA GEOLOŠKIH STRUKTUR NA POVRŠJU NAD PREDJAMO

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Stanka Šebela: Interpretacija geološke strukture površja nad Predjamo z letalskimi posnetki

Stereoskopsko opazovanje letalskih posnetkov v merilu 1:5000 je zelo dobra predhodna informacija pri določitvi geoloških strukturnih elementov na terenu. Značilne morfološke strukture kot doline, nizi dolin kažejo na potek tektonsko pretrih con. Tudi litološke razlike, kot meja med apnencem in flišem je opazna kot značilna morfološka stopnja. Določljiva je tudi narivna meja med triasnim dolomitom in krednim apnencem.
Ta metoda je najbolje preiskušena s podrobnim tektonsko-litološkim kartiranjem na terenu v merilu 1:5000. Primer Predjame kaže nekatere razlike pri primerjavi obeh metod.

Ključne besede: letalski posnetki, geološka struktura, tektonsko porušene cone, diagram polrozete, Predjama, Slovenija.

Abstract UDC 551.442:778.35(497.12)

Stanka Šebela: Aerophoto interpretation of geological structures on the surface above the Predjama Cave

Stereoscopic observing of aerophoto images on the scale 1:5000 is very good information to determine preliminary geologic structural elements in the field. Characteristic morphological structures like dolines, and series of dolines show positions of tectonic crushed zones. Also a lithological difference such as the border between limestone and flysch is visible as a characteristic morphologic step. The nappe border between Triassic dolomite and Cretaceous limestone is determined also. This method is best confirmed with detailed tectonic-lithological mapping in the field on the scale 1:5000. The case of Predjama shows some differences in comparing both methods.

Key words: aerial photography, geological structure, tectonic crushed zones, half-rosette graph, Predjama, Slovenia.

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INTRODUCTION

Predjama cave lies about 7 km NW from Postojna. 7571 m long, it is among the longest horizontal caves in Slovenia.

For studies of development of cave channels (Šebela, 1991; Šebela & Čar, 1991) it was necessary to determine geological properties of underground and surface. Like previous researches for detailed tectonic lithological mapping of surface at the scale 1:5000 according to method of Čar (1982, 1984) we used aerophoto of the surface above Predjama cave at the scale 1:5000, being a new approach, because till now we mostly used snapshots in the scale 1:30.000 or 1:17.500.

The interpretation of aerial photography of the surface is an advantageous method for preliminary field researches and at the same time an important base for detailed tectonic-lithological mapping of the surface.

This article talks about comparison of directions of tectonic crushed zones on the surface above Predjama cave which were determined by interpretation of aerial photography and by detailed tectonic lithological mapping at the scale 1:5000.

GEOLOGICAL DATES

According to L. Placer (1982) in the SW part of Slovenia the old Tertiary tectonics and neotectonics are distinguished. At the end of the Eocene or in the Oligocene the alpine-dinaric region was subject to extensive thrusting. In Miocene and Pliocene the thrusting was associated with folding. Under the term neotectonics Placer (1981) understands steep faults of NW-SE direction which are different to overthrust deformations.

In a tectonic sense the area around Predjama belongs to wider fault zone of the Predjama fault of which inner fault zone passes probably a bit to the west of Predjama.

During detailed tectonic mapping on the surface and by the observation of the aerial photography we distinguished two kinds of tectonic deformations, namely older overthrust and younger fault deformations.

According to data of BGM, sheet Postojna (Buser & Grad & Pleničar 1967) on the treated area there are Triassic dolomites (T_3^{2+3}) thrusted over

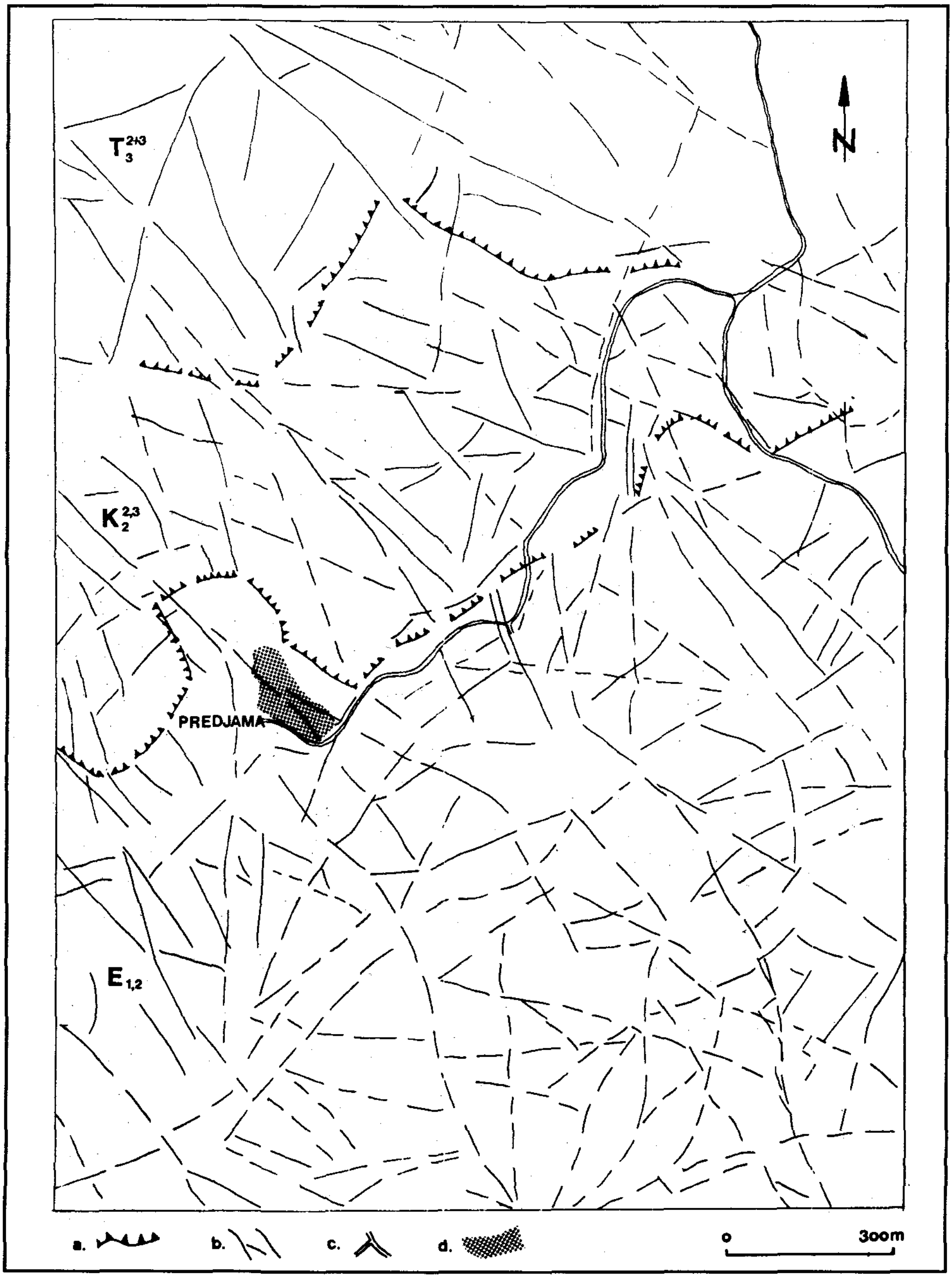

Fig. 1. Interpretation of tectonic crushed zones in aerial photography. a-overthrust line determined by surface mapping, b-tectonic crushed zones determined by aerial photography, c-roads, d-village.

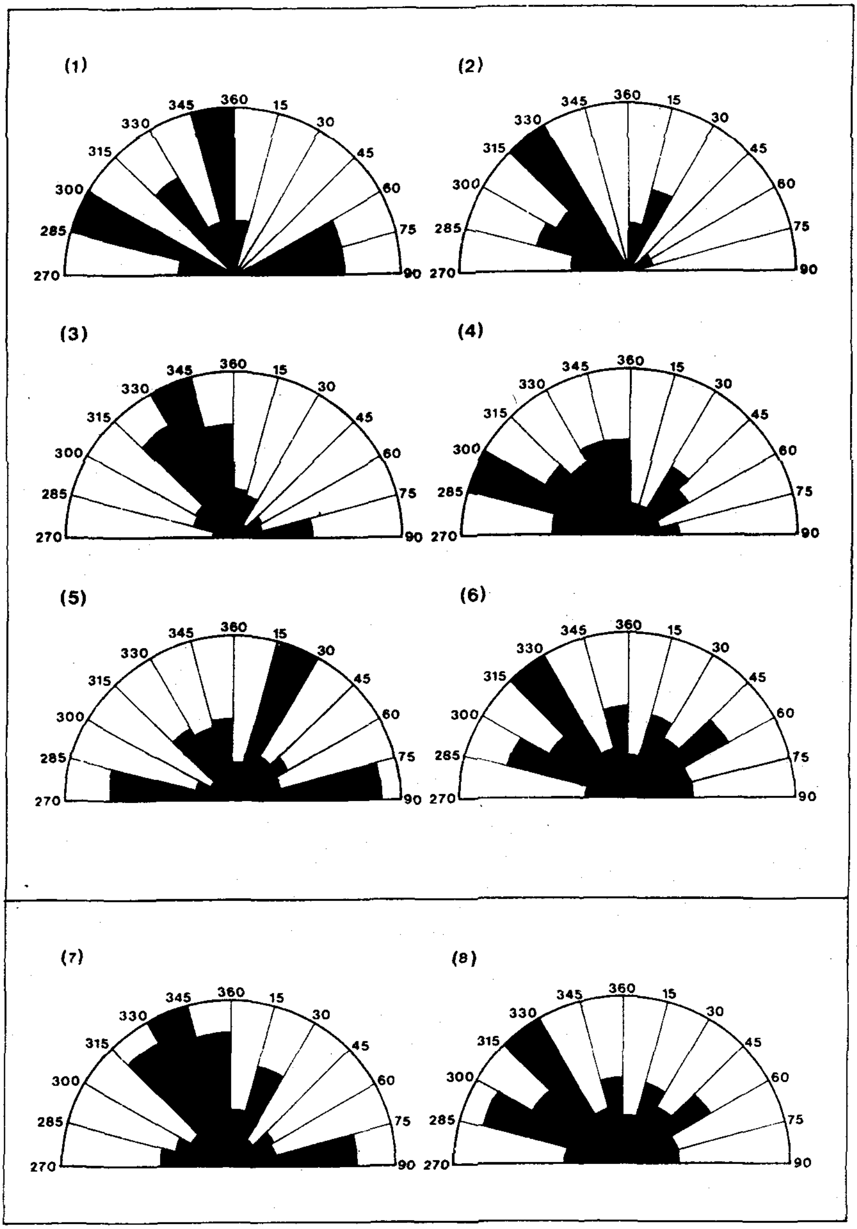

Fig.2. Graphs half-rosettes showing the strike of tectonically crushed zones. (1)dolomite; surface mapping n=15, (2) dolomite; aerial photography n=49, (3) limestone; surface mapping n=187, (4) limestone; aerial photography n=93, (5) flysch; surface mapping n=123, (6) flysch; aerial photography n=248, (7) dolomite, limestone and flysch; surface mapping n=325, (8) dolomite, limestone and flysch; aerial photography n=390.

the Cretaceous limestones (K_2^{2+3}) and Cretaceous limestones thrusted to Eocene flysch ($E_{1,2}$) as is presented by Fig. 1. In tectonic sense the Hrušica tectonic unit is thrusted to the tectonic unit of Javorniki - Snežnik block. On the south there is the flysch of Postojna and Pivka basin. On the west there is the Nanos tectonic unit separated from the Hrušica by Predjama fault (Pleničar 1970).

By stereoscopic observations of two pictures of the same area we distinguished the morphological levels of the terrain which is controlled by the geological setting.

On the picture we defined 390 measurements of directions of tectonic crushed zones, what means 49 in dolomite, 93 in limestone and 248 in flysch. We couldn't distinguish between overthrust and fault deformations, which are in our case also borders between different rocks and between different kinds of tectonic crushed zones according to classification of Čar (1982). All these data were determined later with detailed tectonic lithological mapping in the field.

Interpretation of aerial photographs shows (Fig. 2) that on dolomite and flysch terrain most of the directions of tectonic crushed zones are between

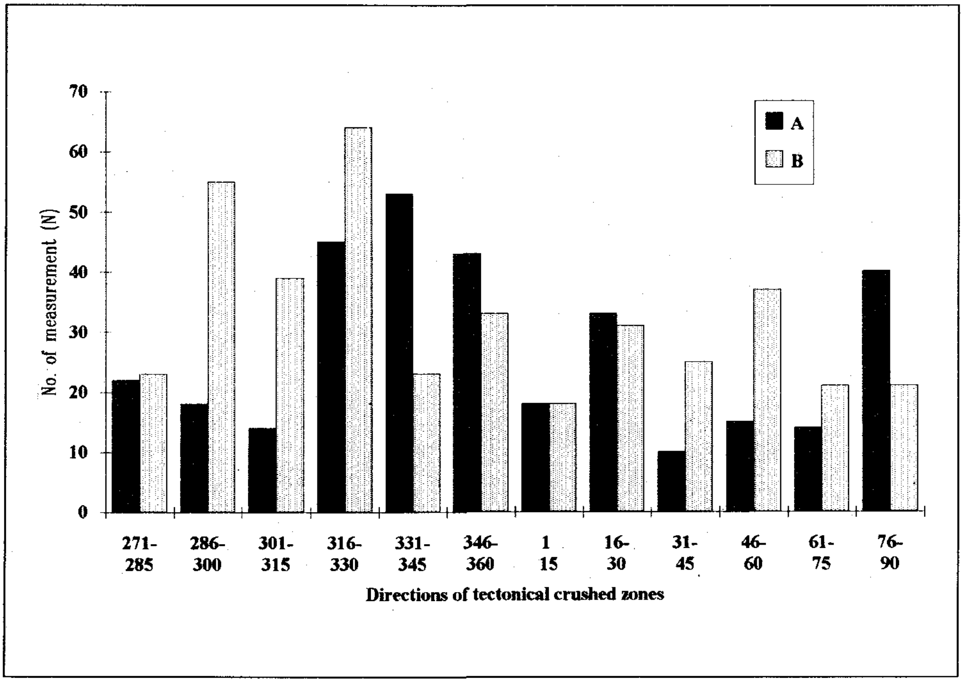

Fig.3.Diagram comparing data of tectonically crushed zones in aerophoto snapshots (A) and in the surface (B) above Predjama cave.

316-330^0 and on limestone terrain the most common are directions between 286-300^0. For the entire terrain the most common direction of tectonic crushed zones is between 316-330^0.

Detailed tectonic mapping of the surface in the scale 1:5.000 has shown complicated relations along the thrust lines. Thus the thrust line dolomite-limestone is dissected and partly displaced by younger fault deformations which is seen on the aerial photographs too. The thrust contact limestone-flysch is deformed as well by younger fault deformations in the east-west direction almost and the Dinaric direction.

Fault deformations were defined on the dolomitic, limestone and flysch terrain. But it must be stressed that the same fault zone is differently manifested within different rocks.

Some main fault zones of the Dinaric direction NW-SE, N-S and E-W predominate on the entire area. The oldest out of them are Dinarically oriented fault zones. Connecting zones among the most important fault zones are fissured or broken zones.

In field researches I included about 3 km^2, out of which 50% belong to flysch, 37.5% to limestone and 12.5% to dolomite.

Statistical processing (half-rosette graph, frequency of directions of the tectonically crushed zones) of the tectonic structural elements, got by the detailed tectonic mapping of the surface in the scale 1:5.000, is shown on Fig. 2.

On dolomitic terrain there are the most of tectonically crushed zones with strike between 286-300^0 and 346-360^0 which is close to the direction east-west, north-south respectively. These data included 15 measurements only (Fig. 2;1).

In limestone the tectonic zones with strike 331-345^0 prevail which correspond to the Dinaric direction. In Fig. 2 (3) 187 field measurements are included.

In flysch (123 measurements) the tectonically crushed zones prevail with strike between 16-30^0 corresponding to cross Dinaric direction (Fig. 2;5).

Graph (half rosette) of the tectonically crushed zones dip for all the three rocks (limestone, dolomite, flysch) on the surface shows that on the treated area the rocks are the most frequently crushed in the direction 331-345^0 which corresponds to the Dinaric direction (Fig. 2;7).

STATISTICAL COMPARISON OF THE DIRECTIONS OF TECTONICALLY CRUSHED ZONES ON THE FIELD AND ON THE AERIAL PHOTOGRAPHS

Comparing the aerophoto interpretation and the tectonic-lithological map (Scale 1:5.000) (Fig. 3) we infer that the main fault zones in Dinaric orientation agree. Partly correspond some cross broken or fault zones and thrust lines.

Statistical processing of the measured data of both methods indicates some characteristical differences.

Graphs half-rosettes showing the strike of tectonically crushed zones in the dolomite (Fig. 2) differ a lot. On the aerial photographs several measurements were seen, namely n=49, while on the field the determination was hindered due to morphology of the dolomitic terrain and grass vegetation. We have defined n=15 measurements only (Fig. 2;1).

The measurements in limestone in the field were more numerous (n=187) than those from the aerial photographs (n=93). The reason could be in wooded areas where the aerophoto interpretation is much more difficult. On the limestone the geological mapping (in spite of vegetation) is the easiest. Dinarically oriented tectonically crushed zones prevail. Both graphs do not agree perfectly, probably due to vegetation (Fig. 2;3,4).

On the flysch area, n=123 measurements were done and on aerophotos n=248. The graphs differ considerably (Fig.2;5,6). But we must consider that flysch is mechanically different from the limestone and dolomite, and that the strongest fault zones are situated in marked dolines and gullies, where flysch is due to tectonics and depositon of flysch material with streams heavily mechanically crushed and thus the measurements of main and, it is true the most important directions for the terrain, tectonically crushed zones are not possible. Accepting these statements the graphs are much better comparable.

CONCLUSION

Without doubt the interpretation of the aerial photographs in the scale 1: 5.000 requires a special knowledge and experience. The preliminary examination of the field properties by the aerophotos could be used for the introductory research and at the same time for later detailed field mapping (mostly of the terrains of difficult access or covered by vegetation). Above all structural geological data, namely tectonic crushed zones, got by the interpretation of the aerial photographs must be checked and classified in the field.

In the case of Predjama we included in the detailed tectonic-lithological mapping n=325 measurements (n=15 on dolomite, n=187 on limestone and n=123 on flysch) which were compared with n=390 measurements on the aerophoto snapshots (n=49 on dolomite, n=93 on limestone and n=248 on flysch). According to statistical data processing the average error of the correspondence of tectonically crushed zones for all the three rocks of the terrain (dolomite, limestone and flysch) and on the aerial photographs is 24,34%.

REFERENCES

Buser, S., Grad, K. & Pleničar, M. 1967: Osnovna geološka karta SFRJ Postojna 1:100.000.- Zvezni geološki zavod, Beograd.

Čar, J., 1982: Geološka zgradba požiralnega obrobja Planinskega polja.- Acta Carsologica SAZU 10 (1981), 75-105, Ljubljana.

Čar, J. & Gospodarič, R., 1984: O geologiji krasa med Postojno, Planino in Cerknico.- Acta Carsologica SAZU 12 (1983), 91-106, Ljubljana.

Placer, L., 1981: Geološka zgradba jugozahodne Slovenije.- Geologija 24/1, 27-60, Ljubljana.

Placer, L., 1982: Tektonski razvoj idrijskega rudišča.- Geologija 25/1, 1-208, Ljubljana.

Pleničar, M., 1970: Tolmač lista Postojna. Osnovna geološka karta SFRJ 1:100.000.- Zvezni geološki zavod Beograd, 62 str., Beograd.

Šebela, S., 1991: Površinske geološke strukture in njihov vpliv na oblikovanje Predjame.- magistrska naloga, 115 str. in 6 prilog, hrani se v knjižnici IZRK ZRC SAZU v Postojni.

Šebela, S. & Čar, J., 1991: Geološke razmere v podornih dvoranah vzhodnega rova Predjame.- Acta Carsologica SAZU 20, 205-222, Ljubljana.

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Povzetek

Predjama leži okrog 7 km SZ od Postojne. S 7571 m dolžine spada med najdaljše horizontalne jame v Sloveniji.

Pri preučevanju razvoja jamskih rovov (Šebela,1991; Šebela & Čar, 1991) je bilo potrebno določiti geološko zgradbo podzemlja in površja. Kot predhodne raziskave za podrobno tektonsko-litološko kartiranje površja v merilu 1:5000 po metodi Čarja (1982, 1984) smo uporabili aerofoto posnetke terena nad Predjamo v merilu 1:5000, kar je novost glede na to, da smo do sedaj večinoma uporabljali posnetke v merilu 1:30.000 ali 1:17.500.

Ta članek obravnava primerjavo smeri tektonsko pretrtih con površja nad Predjamo, ki smo jih določili z interpretacijo aerofoto posnetkov in podrobnim tektonsko-litološkim kartiranjem v merilu 1:5000.

Pri podrobnem tektonskem kartiranju na površju kot tudi pri opazovanju aerofoto posnetkov smo ločili dve vrsti tektonskih deformacij, in sicer starejše narivne in mlajše prelomne deformacije.

Po podatkih OGK list Postojna (Buser, Grad & Pleničar, 1967) je na obravnavanem terenu triasni dolomit (T_3^{2+3}) narinjen na kredne apnence