Organic geochemistry of fossil resins from the Czech Republic

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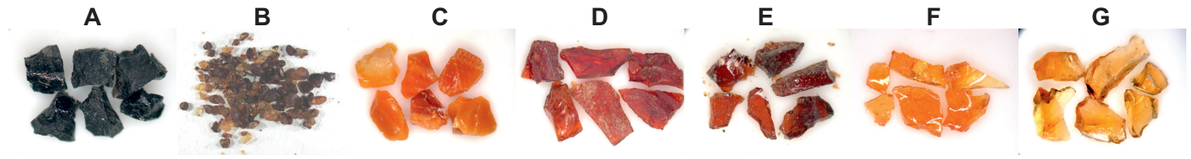
Five fossil resin samples of Cretaceous to Neogene age collected in the area of Czech Republic were chosen to observe differences among them. The purpose of this work is to study chemical and maceral composition of the samples to correlate the resins from different geological locations by elemental and petrographic analysis, pyrolysis–gas chromatography/mass spectrometry using in situ sample derivatisation with tetramethylammonium hydroxide (TMAH-Py–GC/MS), and gas chromatography/mass spectrometry (GC/MS) of resins extracts. For comparison, two ambers were also analysed.

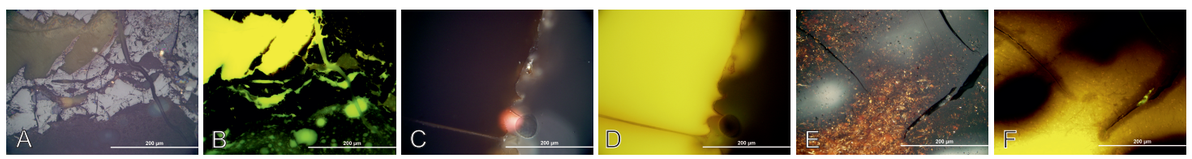
Overview of samples of fossil resins investigated and their maceral composition

Designation	*Locality*	*Lithology*	*Age*	*Maceral composition (vol. %)*
Krizany	Křižany	uranium mine, sands	Cretaceous/Cenomanian	**Liptinite:** 96.5 % **Huminite:** 3.5 %
Straseci	Nové Strašecí	black clays	Cretaceous/Cenomanian	**Liptinite:** 98.2 % **Huminite:** 1.8 %
Valchovite	Valchov	coal clays	Cretaceous/Cenomanian	**Liptinite:** 100 % resinite
Studlov	Študlov	coal slate	Paleogene/Eocene	**Liptinite:** 100 % resinite
Duxite	Bílina	fossil wood in green clays	Neogene/Miocene	**Liptinite:** 100 % resinite
Baltic amber	Burg on Fehmarn (Denmark)	sands	Paleogene/Eocene	**Liptinite:** 100 % resinite
Sarawak amber	Merit Pila (Malaysia)	coal seam	Neogene/Miocene	**Liptinite:** 88.8 % **Huminite:** 10.2 % **Inertinite:** 1.0 %

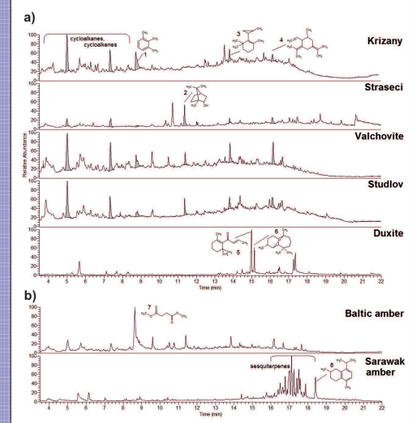
Map of the Czech Republic with sampling locations of fossil resin



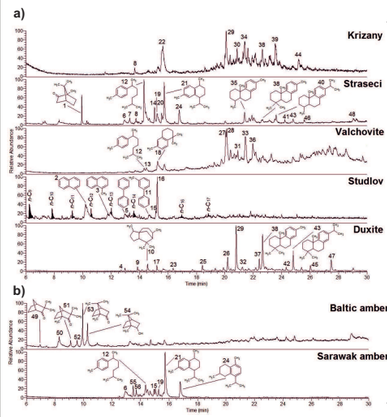
Photomicrographs of resinite occurrences: dark brown, opaque resin - Krizany (A); brown, partly transparent resin - Straseci (B); butterscotch, opaque resin -Valchovite (C); brown, partly transparent resin - Studlov (D); brown, partly transparent, resinous gloss - Duxite (E); brown, partly transparent resin - Baltic amber (F); brown and partly transparent resin - Sarawak amber (G).



Compact form of resinite (R_r = 0.17%) - Sarawak amber (A); yellow fluorescence colour and droplet resinite (R_r = 0.10%); yellow-green colour of fluorescence in mylonitized ulminite (R_r = 0.43%) with fissures filled by exsudatinite - Sarawak amber (B); resinite (R_r = 0.09%) - Studlov (C); yellow fluorescence colour - Studlov (D); fissures in unevenly altered resinite with R_r increased from 0.12% to 0.33% - Krizany (E); yellow fluorescence colour of unaltered resinite and brown to dark fluorescence colour of altered resinite – Krizany (F).



Total ion pyrograms of (a) fossil resins collected in the Czech Republic; (b) ambers. Peaks of the compounds common for Krizany, Straseci, Valchovite, and Studlov samples are shown in gray: dimethylcyclohexene, tetramethylcyclopentene, trimethylbenzene (1), borneol (2), 1,3,3-trimethyl-2-(2-methylcyclopropyl)-1-cyclo-hexene (3), elemenene (4). The most intense compounds are drawn: β-damascone (5) and longipinane (6) in Duxite, succinic acid and methylester (7) in Baltic amber, cadinatriene (8) in Sarawak amber.



No.	Name	No.	Name
1	camphor	29	C18 diterpene (248)
2	naphthalene	30	C18 diterpene (248)
3	methylnaphthalene	31	C18 bicyclic diterpane
4	nordrimane	32	C20 diterpane (276)
5	biphenyl	33	C19 tricyclic terpane
6	dimethyltetraline	34	C19 triterpene
7	sesquiterpene (204)	35	15,16,17-trisnorabieta-8,11,13-triene
8	sesquiterpene (204)	36	C18 bicyclic diterpane
9	sesquiterpene (206)	37	8β(H)-labdan
10	α-cedrane	38	16,17-bisnordehydroabietane
11	methylbiphenyl	39	diterpene (224)
12	dihydro-ar-curcumene	40	18-norabieta-8,11,13-triene
13	4-butyl-indan-1-ol	41	19-norabieta-8,11,13-triene
14	sesquiterpene (202)	42	abietane
15	sesquiterpene (206)	43	dehydroabietane
16	sesquiterpene (204)	44	dimethylphenanthrene
17	sesquiterpene (220)	45	simonellite
18	trimethyltetralin	46	10,18-bisnorabieta-5,7,9(10),11,13-pentaene
19	eudesmadiene	47	retene
20	cuparene	48	L ferruginol
21	calamenene	49	camphene
22	sesquiterpene (204)	50	o-cymene
23	C16 bicyclic sesquiterpene (222)	51	fenchone
24	5,6,7,8-tetrahydrocadalene	52	fenchol
25	C18 diterpene (246)	53	camphor
26	C20 tricyclic terpane (276)	54	borneol
27	tetramethyltetralin	55	sesquiterpene (204)
28	C18 bicyclic diterpane	56	sesquiterpene (204)

Total ion chromatograms of (a) fossil resins collected in the Czech Republic; (b) ambers. The filled peaks are *n*-alkanes.

- ✓ The studied samples represent fossil resins of different age, shape, colour and petrographic characteristics
- ✓ Valchovite, Studlov, Duxite and Baltic amber are pure fossil resins composed of resinite
- ✓ Resinite dominates in Krizany, Straseci and Sarawak amber which include also admixture of plant tissue remnants of the cellulose-lignin base or fragments of lignite macerals
- ✓ Pyrograms of Krizany, Straseci, Valchovite and Studlov reveal similar record but the chromatograms differ significantly: diterpene compounds prevail in the extracts of Krizany and Valchovite, sesquiterpene compounds in extracts of Straseci and Studlov. The results point to the conifer plants as the source tree.
- ✓ Sample of Duxite is quite different from the other fossil resins and the results point to the coniferous family Cupressaceae as the source tree
- ✓ Baltic amber displays typical fingerprint for this type of resin with compounds as succinic acid, fenchol, camphor or borneol (Sciadopityaceae or Pinaceae)
- ✓ Sarawak amber has fingerprints diverging from all studied samples. This amber was produced by angiosperm trees of the genus Dipterocarpaceae

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